TUNICATA

BY

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WITH SEVENTEEN TEXT-FIGURES AND THREE PLATES.

The Tunicata form two ecological groups which coincide with important systematic divisions, the Ascidiacea being benthic, the Thaliacea and Appendicularia planktonic. It will be convenient to treat these groups separately.

ASCIDIACEA.

The value of the collections of the Barrier Reef Expedition is enhanced by the quantity of ecological observations accompanying them, which can be found in the general reports. They are also important as coming from one of the parts of the Australian coast whose Ascidian fauna is less well known, our knowledge depending chiefly on Herdman's Catalogue (1899), which needs revision. The Ascidians of the N.W. and S.W. coasts have recently been studied by Hartmeyer (1919), Hartmeyer and Michaelsen (1928) and Michaelsen (1930).

Geographical Distribution.

From its position at the N.E. corner of Australia, the fauna of the Great Barrier Reef might be expected to show affinities with the Malayan as well as the Australian fauna, and this intermediate position gives it some interest. Until more is known of the species described by Herdman (1882*b*, 1886, 1899) and Sluiter (1895, 1904, 1909), no exact account of the distribution of Tunicates in the Australian and Malayan regions can be given. It is worth noticing, however, that, of the 36 species of Ascidians in the collection, 21 were already known from the Australian coasts and 17 from Malaya. Hartmeyer and Michaelsen (1928, p. 257) also found a relationship between the Australian (W. Australian) tunicate fauna and that of Malaya.

There are only 7 species in the Barrier Reef collection that have not been found beyond the coasts of Australia, and several are widely distributed in the Indian Ocean, some

extending as far as Africa. Records of Australian species in the Atlantic are not numerous and are not generally very convincing. It seems probable, however, that some (*e. g. Ascidia sydneiensis*) really have this very wide distribution. The synonymy of the Tunicata is, however, still too uncertain for detailed discussion to be profitable.

Parasitic and Commensal Associates of the Ascidiacea.

Various parasitic and commensal animals were associated with the Ascidians. They will be included in the appropriate reports of the Barrier Reef Expedition. A list follows:

Lamellibranchs were embedded in the test of specimens of *Polycarpa cryptocarpa* (St. XIX) and *Cnemidocarpa irma* (St. XIX).

The specimen of *Polycarpa procera* (St. XXV) had a Gymnoblastic Hydroid growing on the inner surface of the branchial siphon.

Commensal Amphipods were found in the branchial sac of *Phallusia depressiuscula* (St. XIX), *Polycarpa pedata* (St. XVI) and *Cnemidocarpa irma* (St. XIX, XXII), and in the atrial siphon of *Polycarpa aurita* (St. XIX).

Decapoda natantia were living in the cloacal canals of *Sigillina deerrata* (St. XVII). Individuals belonging to the genus *Pontonia* were present in the branchial sac of *Phallusia depressiuscula* (St. VIII) and *Pyura momus* form *grandis* (St. XIX, XXII).

Parasitic Copepods of the family Notodelphyidae were found in the branchial sac of *Podoclavella meridionalis* (St. XXII) and of both specimens of *Phallusia depressiuscula* (St. VIII, XIX). Specimens of *Polycarpa cryptocarpa* (St. XIX) contained a parasitic Crustacean resembling *Sphaerothylacus polycarpae* Sluiter.

Zooxanthellae have been found in three species of Tunicate from the reef submitted to Dr. C. M. Yonge, namely *Trididemnum cyclops* (p. 89), *Didemnum voeltzkowi* (p. 97) and *Diplosoma virens* (p. 102). The algae are not all of the same kind.

Type-Specimens.

The Amsterdam Museum very kindly lent me type-specimens of the following species described by Sluiter: *Styela aurita*, *S. albopunctata*, *Ascidia limosa*, *Distoma deerratum*, *Polycitor coalitus*, *Didemnum reticulatum*, *D. jedanense*, *D. chartaceum*. They also arranged an exchange of specimens by which we now have examples of most of the species of Appendicularians found by the Siboga and slides of the compound Ascidians mentioned above.

Collecting Stations.

Ascidians were obtained by shore collecting at Batt Reef, Yonge Reef, Three Isles and Low Isles. They were obtained at the following places on Low Isles: A4, F9, between F11 and IR1, G3, IM1, RC, the Sand Flat, the Thalamita Flat, the Mangrove Swamp. The symbols refer to the map of Low Isles given in Dr. Stephenson's Report on the Ecology of the Reef, where particulars of all shore collecting stations will be found.

They were collected by dredge or trawl from the following stations:

II. 24.ii.28. Linden Bank, 28 fath., shell and sand, dredge 10 min. and 5 min.
VIII. 21.ii.29. $1\frac{1}{2}$ miles N.W. Low Isles, 11 fath., mud, Agassiz trawl, 30 min.
IX. 22.ii.29. Penguin Channel, 12–14 fath., clean pit with mud at sides, 6 dredges about 20 min. each.

XII. 24.ii.29. Penguin Channel, 10–15½ fath., rock and shell gravel, mud on edges of pit, 5 dredges about 30 min. each.
XVI. 9.iii.29. About ½ mile W. of N. Direction I., 20 fath., stony, 6 dredges 20–30 min. each.
XVII. 9.iii.29. About ¼ mile N. of N. Direction I., 19 fath., sand, thick *Halimeda*, 2 dredges 40 min. each.
XIX. 10.iii.29. About ½ mile N. Eagle I., 10 fath., shell gravel, rich *Halimeda*, 3 dredges, 20–30 min.
XXI. 11.iii.29. ½ mile N.W. Howick Is., 10 fath., mud and shell, Foraminifera, 2 dredges, 30 and 40 min.
XXII. 11.iii.29. To East of Snake Reef, 13½ fath., mud with Foraminifera and shells, 2 dredges ½ hour each.
XXIII. 12.iii.29. In lee of Turtle Isles, 8 fath., mud and shell, 3 dredges, 30–45 min.
XXV. 17.iii.29. In Papuan Pass, 20–25 fath., Foraminifera and coral fragments, series of dredgings, 2¼ hours in all.

Nomenclature.

The subdivisions of species have been called subspecies, variety or form according to the usage of their authors, and it is therefore probable that, in this paper, they have no uniform significance.

Species of Ascidians in the Collection.

Ptychobranchiata.

Pyuridae.

Pyura momus form *grandis* (Heller).
Microcosmus helleri Herdman.

Styelidae.

Cnemidocarpa irma Hartmeyer.
Polycarpa aurata (Quoy & Gaimard).
P. pedata Herdman.
P. ovata Pizon.
P. fungiformis Herdman.
P. cryptocarpa (Sluiter).
P. aurita (Sluiter).
P. procera (Sluiter).

Polyzoidae.

Chorizocarpa sydneyensis (Herdman).

Botryllidae.

Botryllus gracilis Michaelsen.
B. magnicoecus (Hartmeyer).

Dictyobranchiata.

Ascidiidae.

Ascidia sydneiensis Stimpson.
A. granosa Sluiter.
Phallusia depressiuscula (Heller).
P. julinea Sluiter.

Krikobranchiata.

Clavelinidae (in the sense of Michaelsen, 1930).

Podoclavella meridionalis Herdman.
P. molluccensis Sluiter.
Eudistoma ovatum (Herdman).
Sigillina deerrata (Sluiter).

Didemnidae.

Tridemnum cyclops Michaelsen.
T. savignii (Herdman).
T. natalense Michaelsen.
Leptoclinides reticulatus (Sluiter).
L. lissus sp. n.
Didemnum candidum Savigny.
D. psamathodes var. *skeati* (Sollas).
Didemnum voeltzkowi Michaelsen.
D. chartaceum Sluiter.
D. jedanense Sluiter.
D. (*Polysyncraton*) *magnetae* sp. n.
Diplosoma spongiforme Giard. var. ? Michaelsen.
D. virens (Hartmeyer).
Diplosomoides ostrearium Michaelsen.

Polyclinidae.

Polyclinum macrophyllum subsp. *phortax* Michaelsen.

Pyura momus form *grandis* (Heller).

Cynthia grandis Heller, 1878, p. 97, pl. v, fig. 26.
Pyura momus form *grandis* Hartmeyer & Michaelsen, 1928, p. 441 (synonymy).

Distribution.—E. and S.W. Australia.

Occurrence.—St. XVII (1 specimen), XIX (4 specimens), XXII (5 specimens).

All these specimens have the long processes of irregular shape and distribution on the rim of the anus characteristic of form *grandis*.

One of the specimens from St. XIX has 11 folds on each side of the branchial sac, the other has 12. The convolutions of the ciliated band on the dorsal tubercle are very complicated. The test is dark and rough.

The specimens from St. XVII and XXII are smaller, paler and smooth, but they have 10 or 11 folds on each side of the branchial sac, and their dorsal tubercles, though less complicated than those from St. XIX, are more so than that figured by Herdman (1882*b*, pl. xvii, fig. 9, *Cynthia complanata* = *P. momus* form *grandis*).

The specimens all show the chief characteristics of form *grandis*, and the differences among them may be due to age.

According to Hartmeyer and Michaelsen (1928, p. 440), form *grandis* is a southern cool-water form replaced in the warmer waters of North Australia by form *galei*. These specimens, however, come from the tropical seas of the Barrier Reef, and yet resemble *grandis* rather than *galei* in all points of contrast between these two forms.

Microcosmus helleri Herdman.

Microcosmus helleri Herdman, 1882*a*, p. 54; 1882*b*, p. 131, pl. xiv, figs. 1–4; Hartmeyer, 1919, p. 19, pl. i, figs. 6–9; Van Name, 1924, p. 31; Hartmeyer & Michaelsen, 1928, p. 397 (synonymy).

Distribution.—Cape Jaubert, Torres Straits, Malaya, E. Africa, Curaçao.

Occurrence.—St. XIX (5 specimens), XVI (1 specimen), IX (1 specimen).

These specimens agree very closely with the description of *M. helleri* given by Hartmeyer (1919). The number and arrangement of the longitudinal bars shows general, though not exact, agreement with Hartmeyer's table. The test is thickly covered with shell fragments, etc.

Cnemidocarpa irma Hartmeyer. (Text-fig. 1.)

Cnemidocarpa irma Hartmeyer, 1927, p. 168; Hartmeyer and Michaelsen, 1928, p. 388, figs. 40–42.

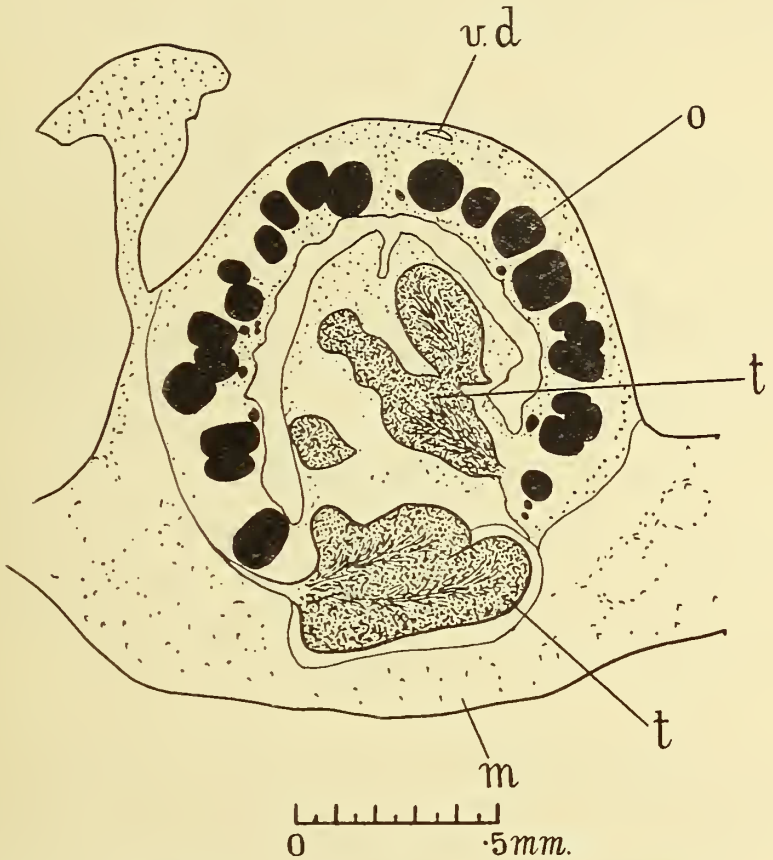
Distribution.—S.W. Australia.

Occurrence.—St. XIX (8 specimens), XXII (10 specimens).

The internal structure of these specimens falls within the range of variation attributed to this species by Hartmeyer, but they differ in their external form, for they appear to have been unattached and are thickly coated with coarse shell fragments, etc. Where the test is visible it corresponds to Hartmeyer's description. There is general agreement in the structure of the mantle, branchial sac and gut. The dorsal tubercle may be round or oval, with the tips of the arms meeting or with one curved in. As in Hartmeyer's specimens, there are three elongated gonads on the right side, one of which may be subdivided, and

two on the left. Hartmeyer's description does not make the arrangement of the ovarian and testicular tissue in the gonad clear, but it appears that the bulk of the testicular tissue is on the outside. If this is so the present specimens differ. In them the testis forms a core covered by a layer of ovarian tissue, only the vas deferens and the vasa efferentia running outside the ovary (Text-fig. 1). The eggs are arranged in an irregular single layer, and the testes from the two sides overlap each other (*cf.* Huntsman, 1913, p. 486).

There is one specimen from St. XIX in which the muscle-bundles in the mantle are rather less distinct and the longitudinal vessels are slightly more numerous. In this



Text-fig. 1.*—*Cnemidocarpa irma* Hartmeyer. Transverse section of a gonad.

specimen the gonads are more numerous and shorter. There are 9 more or less oval gonads on one side, and 13 on the other, some groups having a common duct. In view of Hartmeyer's figure 42 this does not seem a sufficient reason for treating the specimen as distinct. Internally these gonads only differ from those of the other specimens in the more lobed testis.

* *Key to lettering of Text-figures.*—*a.*, anus ; *ab.*, abdomen of Crustacean ; *b.*, bud ; *c.*, cavity in test ; *c.f.*, ciliated funnel ; *cl.*, cloacal canal ; *cr.* Crustacean ; *f*, follicle ; *g*, gonad ; *i*, intestine ; i. 1, 1st section of the intestine, " nachtmagen " ; i. 2, 2nd section of the intestine, " drusenmagen " ; *l.*, lamina on transverse bar ; *m.*, mantle ; *o.*, eggs ; *o.d.*, oviduct ; *oe.*, œsophagus ; *p.*, peripharyngeal bands ; *r.*, rectum ; *s.*, stomach ; *s.v.*, stalked vesicles ; *t.*, testis ; *t.i.*, tissue surrounding intestine ; *t.t.*, thoracic tubercle ; *t.z.*, tentacular zone ; *v.*, vascular process ; *v.d.*, vas deferens.

Polycarpa aurata (Quoy & Gaimard).

Ascidia aurata Quoy & Gaimard, 1834, p. 604, pl. xci, fig. 3.
Polycarpa aurata Hartmeyer, 1919, p. 40 (synonymy, except *P. pedata* Herdman); Sluiter, 1919, p. 3.

Distribution.—Oceania, N.E. and E. Australia, Malaya, Indian Ocean.

Occurrence.—Outer Region, Batt Reef (4 specimens).

These specimens all have a rather smooth test and a hump beside the atrial aperture. The structure of the test and the internal anatomy agree well with the descriptions of Herdman (*P. sulcata*) and Hartmeyer. The collector notes their colour in life as yellow with purple streaks, the characteristic coloration figured by Quoy and Gaimard.

Polycarpa pedata Herdman.

Polycarpa pedata Herdman, 1882*a*, p. 71; 1882*b*, p. 180, pl. xxiv, figs. 1, 2; Van Name, 1918, p. 97, pl. xxiii, figs. 1–3 (synonymy).

Distribution.—E. Australia, Malaya.

Occurrence.—St. XVI (1 specimen).

This specimen, which has the external appearance of *P. pedata*, also differs from the Barrier Reef specimens of *P. aurata* in the internal characters noticed by Van Name, namely more numerous longitudinal vessels, short rectum, gonads longer and anastomosing. There is also a difference in the test, that of *P. pedata* being thinner and free from the knobbed ends of the vessels that give a spotted appearance to a cut surface of that of *P. aurata*. Examination of the type of *P. pedata* (B.M. 87.2.4.125) shows that it has a similar thin test, and so has the only other specimen available for comparison (B.M. 80.11.19.5 from Port Phillip Heads). It seems possible, therefore, that this is another point of distinction between these two forms.

Polycarpa ovata Pizon. (Plate I, figs. A and B.)

Polycarpa ovata Pizon, 1908, p. 211, pl. xi, figs. 15–20; Van Name, 1918, p. 101, pl. xxxi, fig. 31, text-figs. 53–55.

Distribution.—Amboina, Philippines.

Occurrence.—St. XVI (1 specimen).

This specimen agrees fairly well with the descriptions of Pizon and Van Name. Externally (Plate I, fig. A) it is smoother and it is attached by a cluster of rooting processes. The dorsal tubercle has the tip of its right arm curved outwards. The gut is of remarkably small size and has an endocarp in the first loop. Van Name describes more longitudinal vessels between the folds than Pizon does. In this and in the position of the atrial orifice (Plate I, fig. B) the Barrier Reef specimen agrees with Pizon's. The folds of the branchial sac resemble Pizon's in projecting very slightly and being broad at the base. The mantle consists of an outer layer of transverse muscle, a middle layer of longitudinal muscles and an inner spongy layer.

The agreement with the published descriptions not being complete and material for comparison not being available, this determination is tentative.

Polycarpa fungiformis Herdman.

Polycarpa fungiformis Herdman, 1899, p. 43, pl. Cyn. xvi, figs. 1–10.

Distribution.—Moreton Bay, Queensland.

Occurrence.—St. XXV (1 specimen).

This specimen agrees exactly with Herdman's description, except that the dorsal fold on each side projects like the others.

The brown dots are found, not only in the mantle, but in the tissues of the branchial sac and endostyle.

Polycarpa cryptocarpa (Sluiter).

Styela cryptocarpa Sluiter, 1886, p. 210, pl. ii, fig. 1, pl. vii, figs. 1–3; 1891, p. 333.
Polycarpa cryptocarpa Hartmeyer, 1907, p. 17.
Pandocia (*Polycarpa*) *cryptocarpa* Michaelsen, 1911, p. 152.

Distribution.—Billiton Is. (Dutch E. Indies), Japan.

Occurrence.—St. II (1 specimen), St. XIX (3 specimens).

These specimens agree very closely with Sluiter's description. All those from St. XIX contain parasitic Crustacea resembling *Sphaerothylacus polycarpae* Sluiter, which was originally discovered in the type of *P. cryptocarpa*.

Polycarpa aurita (Sluiter). (Text-fig. 2 A–C.)

Styela aurita Sluiter, 1891, p. 338, pl. ii, fig. 12.
Polycarpa aurita Hartmeyer, 1919, p. 81, pl. ii, figs. 43–47 (synonymy); Sluiter, 1919, p. 3.

Distribution.—N.W. Australia, Malaya.

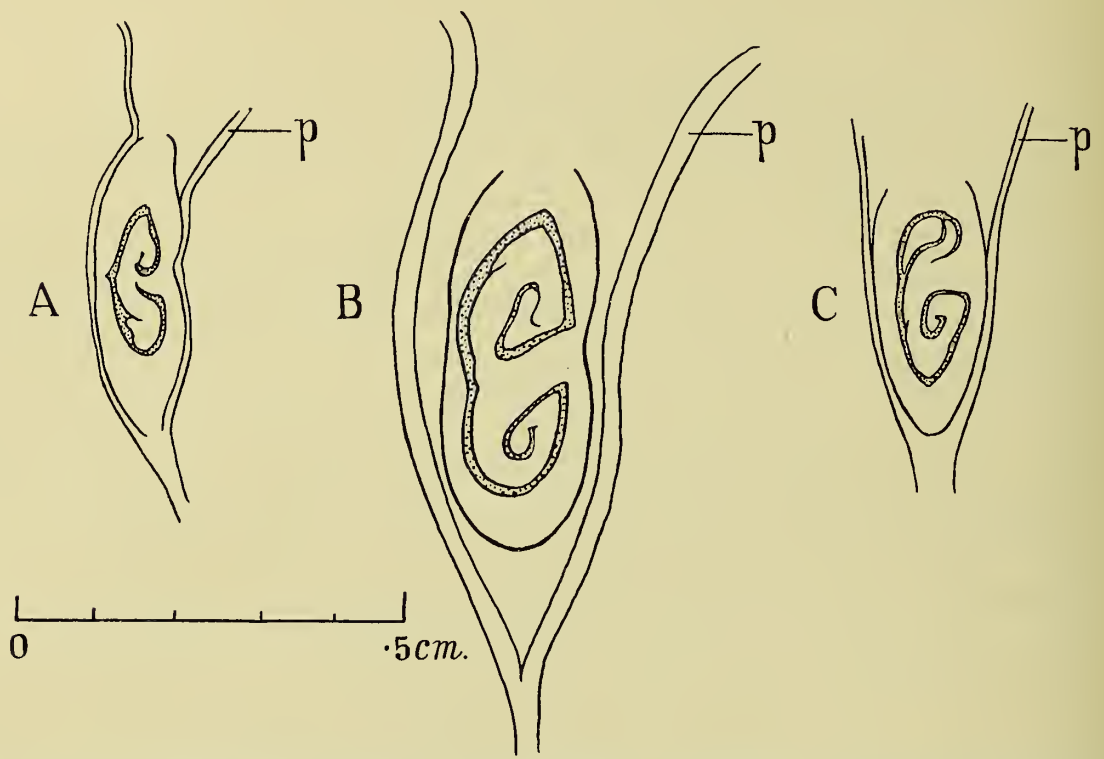
Occurrence.—St. IX (1 specimen), XXIII (2 specimens), XIX (1 specimen).

The main part of the test of these specimens (except the one from St. XIX, which differs in various ways) is very dark brown, and the siphons and surrounding areas are deep buff colour. They are rather darker than Sluiter's types, kindly lent to me by the Amsterdam Museum. Those described by Hartmeyer have the lighter colour of the types. Posteriorly there is a distinct, flattened stalk with root-like processes at its end, In the specimen from St. IX the siphons are fairly prominent; in the others they are quite flat.

In internal structure these specimens agree with Hartmeyer's description. The dorsal tubercle is of the type figured by Hartmeyer, but the ciliated groove has no wider middle portion. Hartmeyer found a similar dorsal tubercle in one of the original specimens, but this is not the pattern in the holotype,* and a paratype examined by me (Text-figs. 2 A, C). In them there is a T-shaped ridge projecting inwards from the left side of the tubercle, with curled arms. The groove, therefore, describes a double spiral rather than a series of loops. The endostyle in the types and in the Barrier Reef specimens consists of a pair of tumid ridges with a narrow groove between. The ridges become less tumid posteriorly.

* Three unopened specimens, one of which I opened, and an open one, which I take to be the holotype, were lent to me.

The specimen from St. XIX measures 8·5 × 2·5 cm. and has no stalk. It differs from the other specimens of *S. aurita* chiefly in the branchial sac, which has much more numerous longitudinal vessels. The limits of the folds are so indistinct and the longitudinal vessels so numerous that accurate counting is impossible. There are roughly 40 vessels in the space between each pair of folds and 50 to 60 on each fold. The tentacles are small and fine, scarce and unevenly distributed, there being eight on the ventral side and none on the dorsal. Those of the type-specimens are evenly distributed, and may be thick (type) or thin (paratype). The dorsal tubercle is of the kind with a T-shaped ridge, but the arms are more coiled and both turn to the left (Text-fig. 2 B).



TEXT-FIG. 2.—*Polycarpa aurita* (Sluiter). Dorsal tubercle. A, Holotype. B, Specimen from St. XIX. C, Paratype. *p.*, peripharyngeal band.

Styela circumarata Sluiter (1904, p. 70) appears to be a closely related species.

The test round the branchial orifice of the specimen from St. IX bears Polyzoa of the genus *Nolella* (*Cylindroecium*).

Polycarpa procera (Sluiter). (Text-fig. 3.)

Styela procera Sluiter, 1886, p. 196, pl. i, fig. 9, pl. v, figs. 5–9.
Polycarpa procera Hartmeyer, 1919, p. 52, pl. i, figs. 24–26, text-figs. 5–13; Hartmeyer & Michaelsen, 1928, p. 378.

DISTRIBUTION.—Australia, Malaya.

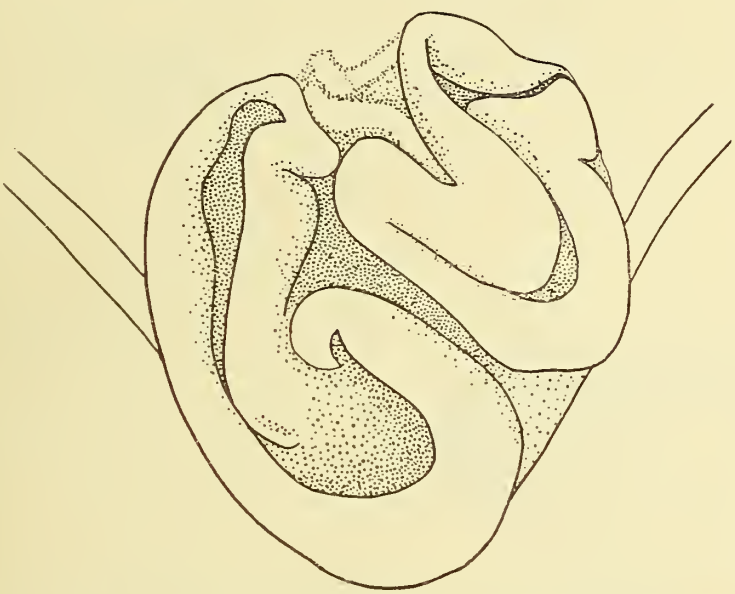
OCCURRENCE.—St. XXV (1 specimen).

This specimen resembles Hartmeyer's Text-fig. 7 in form, but the ventral end is somewhat turned towards the atrial orifice. The convex antero-ventral edge so produced bears a thick band of coarse sand and shell fragments. The rest of the test is uniformly

coated with sand and is brittle. The internal structure corresponds to Hartmeyer's description. The branchial sac is extremely transparent. The gut has the course shown by Hartmeyer in pl. i, fig. 26. There are twelve gonads on each side. The velum is wide and produced into two lobes, a blunt one on the dorsal side of the atrial aperture and a pointed one on the ventral side.

The dorsal tubercle (Text-fig. 3) resembles Sluiter's in being very irregular, but the pattern is quite different.

The lining of the branchial siphon bears a thick growth of a Gymnoblastic Hydroid.



Text-fig. 3.—*Polycarpa procera* (Sluiter). Dorsal tubercle. Actual length of longest diameter, 1 mm.

Chorizocarpa sydneyensis (Herdman).

Chorizocormus sydneyensis Herdman, 1899, p. 95, pl. Pst. i, figs. 1–7.
Chorizocarpa sydneyensis Michaelsen, 1904, p. 93, pl. ii, figs. 24–26 (synonymy).

Distribution.—Port Jackson.
Occurrence.—Yonge Reef.

Botryllus gracilis Michaelsen. (Text-fig. 4 a–e.)

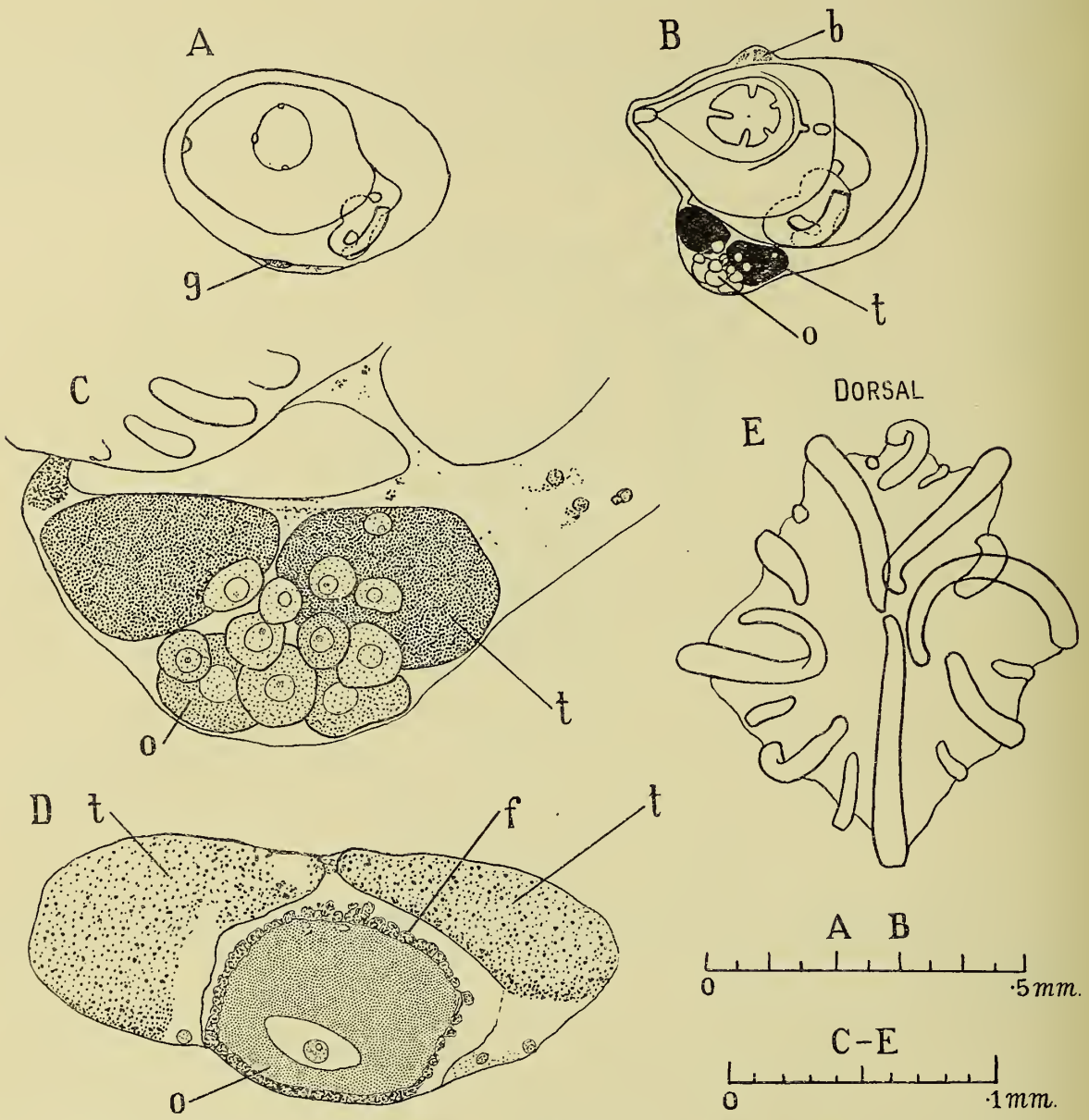
Botryllus gracilis Michaelsen, 1927, p. 203; Hartmeyer & Michaelsen, 1928, p. 338, fig. 22.

Distribution.—Shark's Bay, S.W. Australia.
Occurrence.—St. XXII, on sponge.

The formation of buds at the centre of the primary systems was not seen, but the agreement in other ways is so close as to leave no doubt of the identity of these specimens with Michaelsen's species. The long atrial siphon and the form of the stomach and caecum are specially characteristic points.

The tentacles are remarkable in that, although they occupy the positions in which they are usually found in *Botryllus*, they develop in sets of five instead of four, and, since

their relative sizes depend on the order of their development, the distribution of large and small ones in the adult zooid is different (Text-fig. 4 E). In Text-fig. 4 B the first five are formed, and in Text-fig. 4 A only the first three are distinguishable.

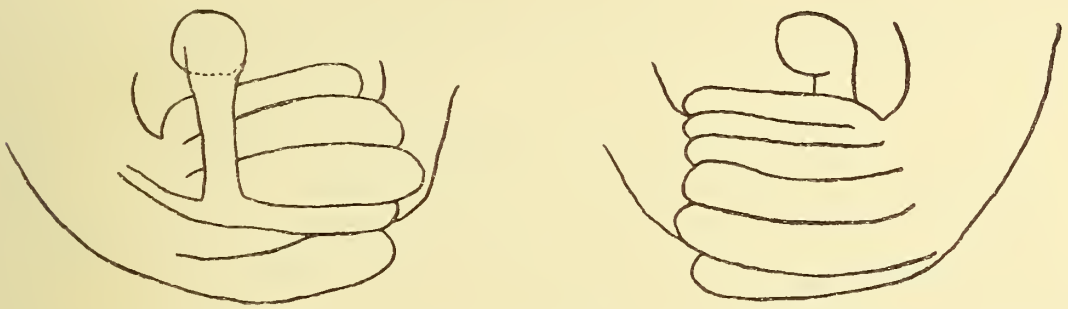


TEXT-FIG. 4.—*Botryllus gracilis* Michaelsen. A, Slightly oblique view of young zooid with first rudiment of gonad. Details of branchial sac omitted. B, Similar view of older zooid. C, Part of B, more highly magnified. D, Parasagittal section of gonad of still older zooid. E, Tentacles. (For explanation of lettering, see footnote, p. 73.)

The animals are hermaphrodite. Michaelsen found the gonads of one side usually more developed than those of the other, which were often completely absent.

In the present specimens gonads are developed on the left side only. A small bud occupies a corresponding position on the right side. In the zooids without gonads a bud is occasionally developed on the left side.

In the earliest stage seen the gonad is represented by a thickening of the inner wall of the mantle (Text-fig. 4 A). As the gonad develops, the mantle becomes distended till the gonad comes to lie in a wide space between the inner and the outer layer (Text-fig. 4 B, C). The testis, consisting of two follicles, occupies the inner part, and the ovary the outer. The vas deferens was not detected. The ovary at first consists of a large number of small eggs. Later, one of these increases greatly in size and becomes enclosed in a follicle. This egg comes to lie on the basal side of the testis (Text-fig. 4 D). In two such eggs a protuberance towards the inner side of the mantle was seen (*cf.* Ärnbäck, 1923, pp. 7, 14, etc.), but no trace of the formation of an oviduct. No later stage than this was found. In view of the work of Ärnbäck (1923) on the reproduction of *B. schlosseri* and *Botrylloides* (*Metrocarpa*) *leachii* particulars of other species are of much interest. It is unfortunate that the material of *B. gracilis* does not show the later stages which are of chief importance for classification. The early stages, however, afford comparisons of some interest. All three species agree in the position of the young gonads



Text-fig. 5.—*Botryllus magnicoecus* (Hartmeyer.) Two views of the same stomach. × 120.

and their relation to the mantle. The development of gonads on one side only in *B. gracilis* and the double testis are obvious points of contrast. It is not clear whether the rudiments of ovary or testis appear first, but there can be no doubt that they appear at nearly the same time.

Botryllus magnicoecus (Hartmeyer). (Text-fig. 5.)

Botrylloides nigrum var. *magnicoecum* Hartmeyer, 1912, p. 271, pl. xli, fig. 11 ; 1913, p. 135.
Botryllus magnicoecus Hartmeyer & Michaelsen, 1928, p. 331 (synonymy).

Distribution.—China, Indian Ocean, Portugal ? Mediterranean ?

Occurrence.—Yonge Reef.

There is one small, almost colourless colony which shows the chief characteristics of this species, namely the stomach with nine folds and a very large caecum, the test-vessels with sharply defined, spherical ends, and the branchial sac with ten rows of stigmata. It differs in the shape of the stomach, which is as long or longer than it is broad, and has the cardiac ends of the folds prominent as in *Botrylloides* (Text-fig. 5). The buds have a thickening of the mantle posteriorly on the left side.

Ascidia sydneiensis Stimpson.

Ascidia sydneiensis Stimpson, 1855, p. 387 ; Hartmeyer & Michaelsen, 1928, p. 285 (synonymy).

Distribution.—Australia, Malaya, Indian Ocean, Atlantic.
Occurrence.—St. XII (1 specimen), XXV (2 specimens).

Ascidia granosa Sluiter.

Ascidia granosa Sluiter, 1904, p. 36, pl. v, figs. 1–14 ; Hartmeyer, 1907, p. 21.

Distribution.—Malaya (Siboga stn. 310), Japan, Holothuria Bank, N.W. Australia, 34 fms. (B.M. 92.1.29.402).

Occurrence.—St. XVII (1 specimen).

This specimen agrees very closely with Sluiter's description. Its dimensions are 5 cm. × 2 cm. The test is very thin, consisting of little more than an adhesive in the interstices of the layer of shell fragments, etc. The mantle and branchial sac, though brown, are very transparent, so that the outer covering can be seen through them.

Phallusia depressiuscula (Heller). (Text-fig. 6 A.)

Ascidia depressiuscula Heller, 1878, p. 87, pl. i, fig. 3.
Phallusia depressiuscula Van Name, 1918, p. 116, pl. xxvii, figs. 10–13, text-figs. 72–74.

Distribution.—Indian Ocean, Malaya.

Occurrence.—St. VIII (1 specimen), XIX (1 specimen).

These specimens can be identified with *Ascidia depressiuscula* as described by Heller and re-described by Van Name. The dorsal tubercle is small and round, with a transverse slit-like opening, thus resembling that of *Ascidia limosa* Sluiter (1887, p. 257) rather than that of *P. depressiuscula*. According to Van Name the opening in *P. depressiuscula* may be simple V- or U-shaped. The course of the digestive tract is similar to that shown by Van Name (figs. 72 and 73), but the loops are longer and narrower (Text-fig. 6 A). The papillae of the branchial sac are as figured by Van Name and have the membrane from their convex border extending halfway to the next longitudinal vessel.

As in Heller's specimen, the blood-vessels in the test are very finely and profusely branched and are conspicuous for their dark colour, which here is dark brown in the main trunks, blackish-purple in the ramifications.

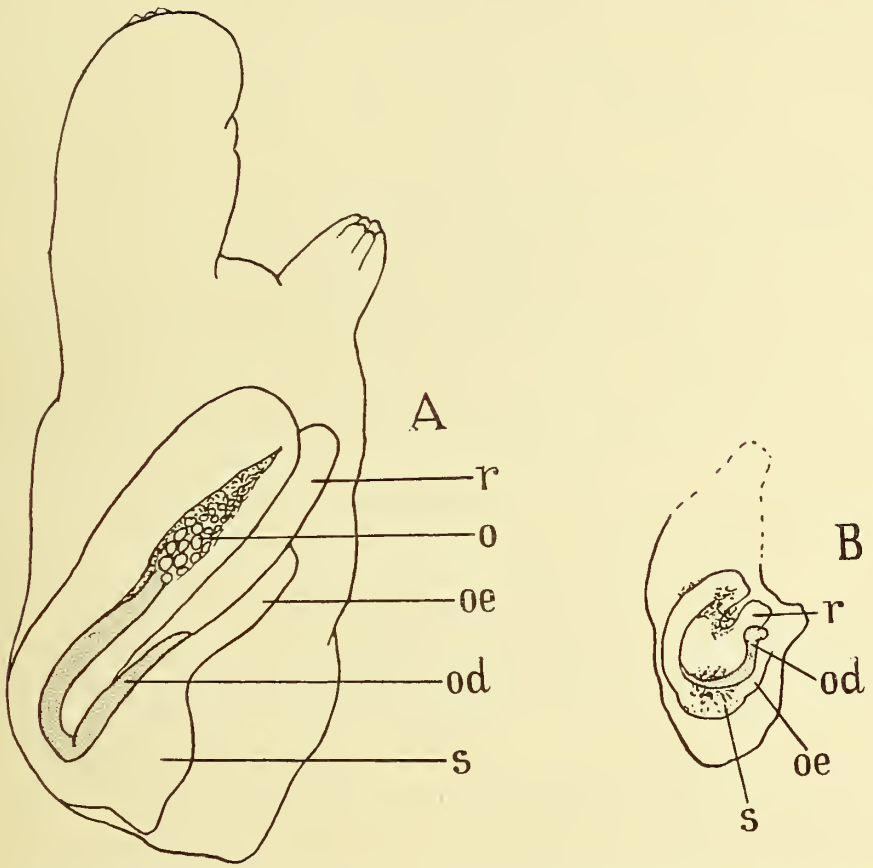
The Zoölogisch Museum, Amsterdam, kindly lent me the type-specimen of *Ascidia limosa* Sluiter for comparison with these specimens, and it seems worth while to record the following points in its structure : The animal without the test measures 2·2 cm. × 1 cm. The intestine is rather more inflated at the second bend than is shown in Sluiter's figure (Text-fig. 6 B). A thick genital duct runs between the rectum and the œsophagus. The branchial sac extends beyond the viscera posteriorly. There is a row of short transverse muscles bordering the right side of the mantle just as in *Ascidia sydneiensis*. The papillae of the branchial sac are thicker and blunter than in Sluiter's figure, and may have blunt lateral processes. They somewhat resemble those of *P. depressiuscula*, but there is no membrane extending from the papillae along the transverse vessels.

Phallusia julinea Sluiter.

Phallusia julinea Sluiter, 1919, p. 7, pl. i, figs. 13–16 ; Hartmeyer, 1919, p. 99, pl. ii, figs. 51–53, text-fig. 20 ; 1927, p. 165, text-fig. 2.

Distribution.—Java Sea, N. and E. Australia.

Occurrence.—St. IX (1 specimen), XXIII (1 specimen).



Text-fig. 6.—A, *Phallusia depressiuscula* (Heller). B, Type of *Ascidia limosa* Sluiter. Branchial region was separate, dotted outline therefore approximate. Both × 2. (For explanation of lettering, see footnote, p. 73.)

Podoclavella meridionalis Herdman. (Plate I, figs. D and E.)

Podoclavella meridionalis Herdman, 1891, p. 603; 1899, p. 4, pl. Clav. ii, figs. 1–4 ; Hartmeyer, 1919, p. 104.

Distribution.—Port Jackson, N.S.W., Cape Boileau (B.M. 30.9.23.7) and Cape Jaubert, N.W. Australia.

Occurrence.—St. XXII (1 specimen).

This specimen agrees very closely with Herdman's description. Its dimensions are as follows : Total length, 10 cm. ; length of stalk 6·5 cm. ; breadth of stalk ·2 cm. ; breadth of body at widest part ·8 cm. (Plate I, fig. D). The test contains feathery crystals soluble in nitric acid, but these were not seen in the Cape Boileau specimens.

The mantle is a more or less deep purple colour over the abdomen and the sides of the thorax. Over the atrium it is colourless and transparent. In this region there are

some longitudinal muscle-bands whose ends turn round and give the effect of a longitudinal row of short transverse muscle-bands, showing white against the purple sides. The horizontal membranes of the branchial sac are wide and bright yellow. Their colour can be seen externally through the transparent atrial part of the mantle as yellow stripes. The dorsal tubercle is oval, placed longitudinally, with a slit-like opening in its long axis. There are a number of embryos in the atrium.

The specimens from Cape Boileau have shorter, thicker, less horny stalks (Plate I, fig. E), less yellow pigment, and the longitudinal musculature is not so regular.

Podoclavella molluccensis Sluiter. (Plate I, fig. F.)

Podoclavella molluccensis Sluiter, 1904, p. 5 ; Van Name, 1918, p. 130, figs. 85–87.
Clavelina (*Podoclavella*) *meridionalis* Sluiter, 1895, p. 165, pl. vi, figs. 1–4.
Podoclavella meridionalis Pizon, 1908, p. 197, pl. ix, figs. 1–4.
non *P. meridionalis* Herdman, 1891, p. 603; 1899, p. 4.

DISTRIBUTION.—Cape Boileau, N.W. Australia (B.M. 30.9.23.8), Malaya.

OCCURRENCE.—St. XIX on *Pyura momus* form *grandis*.

The colonies are characteristic in form and colour. The yellow band below the siphons is continued as a stripe down the atrial wall as described by Pizon, and there may be a patch of yellow over the proximal end of the endostyle. The basal common test is not very thick (3 mm. at most), but the tips of the viscera are embedded in it. In the mantle there are longitudinal muscle-bands, and underneath them a more or less continuous layer of transverse muscle as described by Van Name. The longitudinal muscles can hardly be detected by reflected light and this probably led Sluiter to overlook them. Plate I, fig. F, shows the specimen from Cape Boileau.

Michaelsen (1930, pp. 466 and 476) distinguished his subfamily Clavelininae from the social forms of Polycitorinae by the unlobed branchial aperture. Van Name described his specimens as having a six-lobed branchial aperture, and Michaelsen (p. 467) would therefore put this species in *Polycitor*, but other authors describe it as plain, and it certainly is so in the present specimens.

Eudistoma ovatum (Herdman). (Plate I, fig. C; Text-figs. 7 A–C, 8 A–C.)

Psammaplidium ovatum Herdman, 1886, p. 246, pl. xxxi, figs. 13–16.
Polycitor (*Eudistoma*) *paesslerioides* Michaelsen, 1914, p. 428 ; 1915, p. 440 ; 1921*b*, p. 7 (var. *hupferi ?*).
? *Eudistoma paesslerioides* var. *hupferi* Sluiter, 1927, p. 80.

DISTRIBUTION.—Torres Straits, Cape Boileau, N.W. Australia (B.M. 30.9.23.19), Indian Ocean ? W. Africa, Morocco ?

OCCURRENCE.—St. XVII (1 colony).

This colony, which is incomplete basally, measures 2·8 × 1·5 cm. It is club-shaped (Text-fig. 8 C), and was presumably fixed by its narrow base. The colony from Cape Boileau (Plate I, fig. C) has a diameter of 16 cm. and is 9 cm. in height. The Barrier Reef specimen agrees very closely with Herdman's types which are in the British Museum. The surface of the colony bears a regular layer of fine sand, which is only interrupted by the apertures of the zooids. Internally the sand-grains are larger and irregularly scattered. The zooids measure 8–10 mm. when well expanded. Herdman gave the length as 4 mm.,

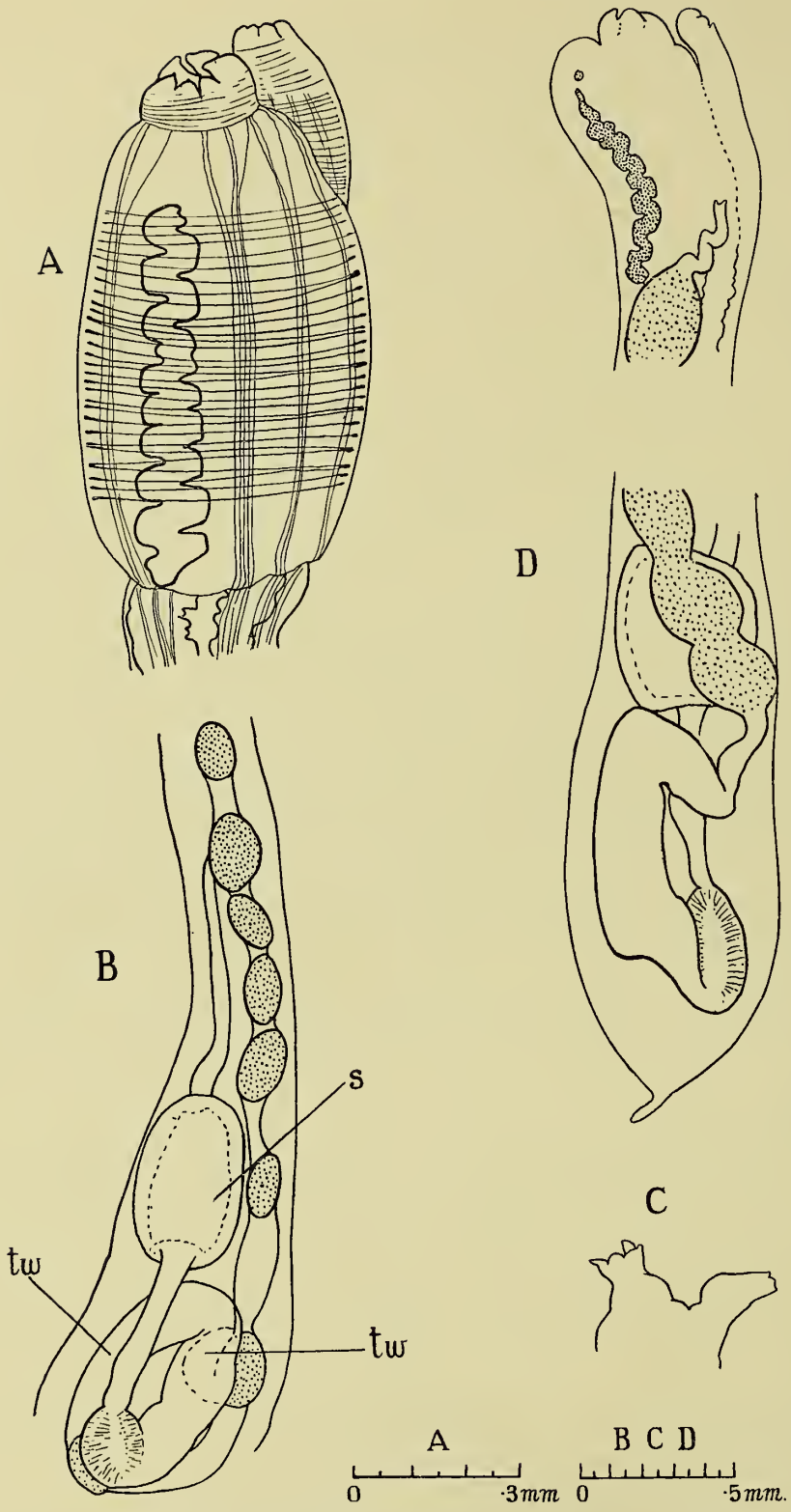
and many contracted zooids in his specimens are no longer than this. Others, however, are expanded, and are as long as those from the Barrier Reef. They consist of a relatively short thorax and a very long abdomen. The end of the abdomen, containing the stomach and gonads, is as wide as the branchial sac, but the part between, through which the oesophagus and rectum pass, is narrower. This contracted part is the structure regarded by Herdman as an elongated post-abdomen. The tip of the abdomen is pointed and continued as a thread in the test for some distance. The transverse musculature on the thorax is very conspicuous on contracted zooids (Text-fig. 7 A). There are 4–6 longitudinal muscle-bundles on each side of the thorax, which coalesce to form broader bundles on the abdomen. The branchial and atrial siphons are six-lobed, and open directly on the surface of the colony.

Owing to contraction of the thorax, the arrangement of the tentacles in the type cannot be made out clearly. They are numerous and elongated. In the specimen from Cape Boileau (Text-fig. 8 A) they are arranged in several rows over a rather wide zone at the base of the branchial siphon. The short atrial siphon, at right angles to the thorax, shown in the figure is not characteristic. In most zooids it is directed forward beside the branchial siphon, and appears as long as the branchial siphon (Text-fig. 8 B), or even longer. In Herdman's specimen there are generally two complete twists in the intestinal loop (Text-fig. 7 B). One twist may occur in the Barrier Reef specimen. The difference presumably depends on the degree of contraction of the zooid. It can hardly be regarded as of systematic importance. The ovary may contain two good-sized eggs. The testis consists of numerous spherical follicles. There may be one or two embryos in the atrium, which is then more or less distended, but there is no distinct brood-pouch.

Hartmeyer (1909, p. 1470) pointed out the artificiality of the genus *Psammaplidium*. There can, I think, be no doubt of the propriety of putting *P. ovatum* in *Eudistoma*, whatever views may be held about the relation of that subgenus to the other Polycitorinae (see Michaelsen, 1930, p. 476).

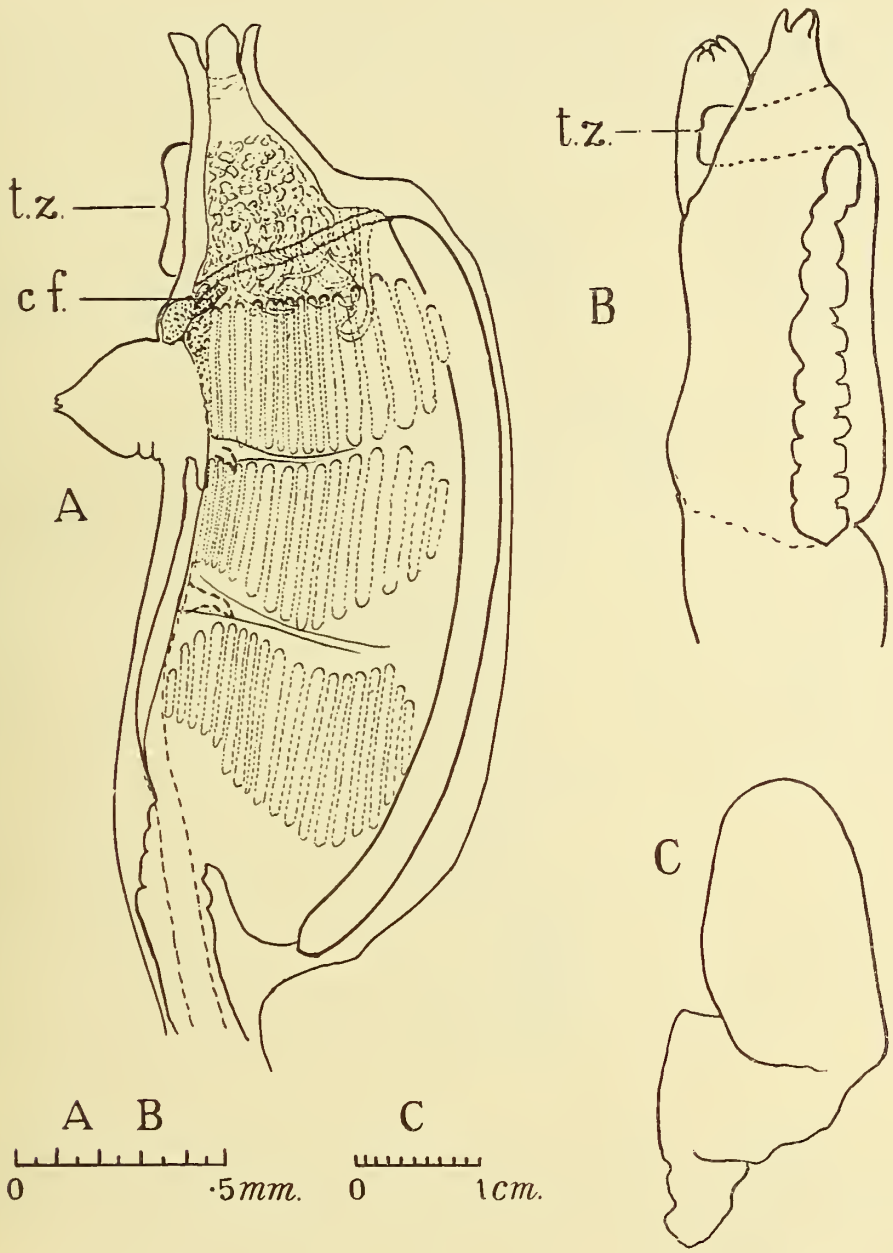
The species identified with *Psammaplidium ovatum* Herdman by Sluiter both appear to be distinct. In that from Torres Strait (1895, p. 170, pl. vii, figs. 3–5) the zooids have a post-abdomen, an atrial languet, longitudinal folds on the stomach, and more than three rows of stigmata. That from between Sumbawa and Celebes (1909, p. 100) evidently had short zooids, for he says that it agrees with Herdman's description and it is included in *Aplidium*. I have, on the other hand, no doubt that *Polycitor* (*Eudistoma*) *paesslerioides* Michaelsen is a synonym of *E. ovatum*. It is not clear to which, if any, of Michaelsen's varieties of *E. paesslerioides* the Australian specimens belong, and he says himself (1930, p. 492) that some of his varieties may be found not to stand. The small number of longitudinal and transverse muscle-bundles bring the type-specimen of *E. ovatum* nearer to var. *hupferi*, and this view is supported by the only half-series that can be counted containing twelve stigmata. The form of the atrial siphon, though varying according to the degree of contraction, is not against this conclusion. The Barrier Reef and Cape Boileau specimens have more numerous stigmata (14–18 in a half-row). There are 7 or 8 longitudinal muscle-bundles and more than 30 transverse bands.

Herdman (1899, pp. 85–89) records eight species of *Psammaplidium* from Australia. Five of these species have not been available for examination, but appear to belong to the Polyclinidae. The other three are *P. ovatum*, *P. spongiforme* and *P. pyriforme*. The accuracy of Herdman's description of *P. spongiforme* has been confirmed by examination



Text-fig. 7.—A, B, C, Type-specimen of *Eudistoma ovatum* (Herdman). A, Thorax. B, Tip of abdomen. Total length of abdomen 8 mm. C, Branchial and atrial siphons. D, Zooid from type-specimen of *Eudistoma pyriforme* (Herdman). Middle part omitted. Total length of zooid 6 mm. *s.*, stomach. *tw.*, twist in intestine.

of the type (B.M. 87.2.4.382). According to his definition of the genera of Polyclinidae, Hartmeyer (1909, p. 1464) justly included this species in *Macroclinum*. Examination of the type of *P. pyriforme* (B.M. 87.2.4.482) shows that it is a *Eudistoma*, closely allied to

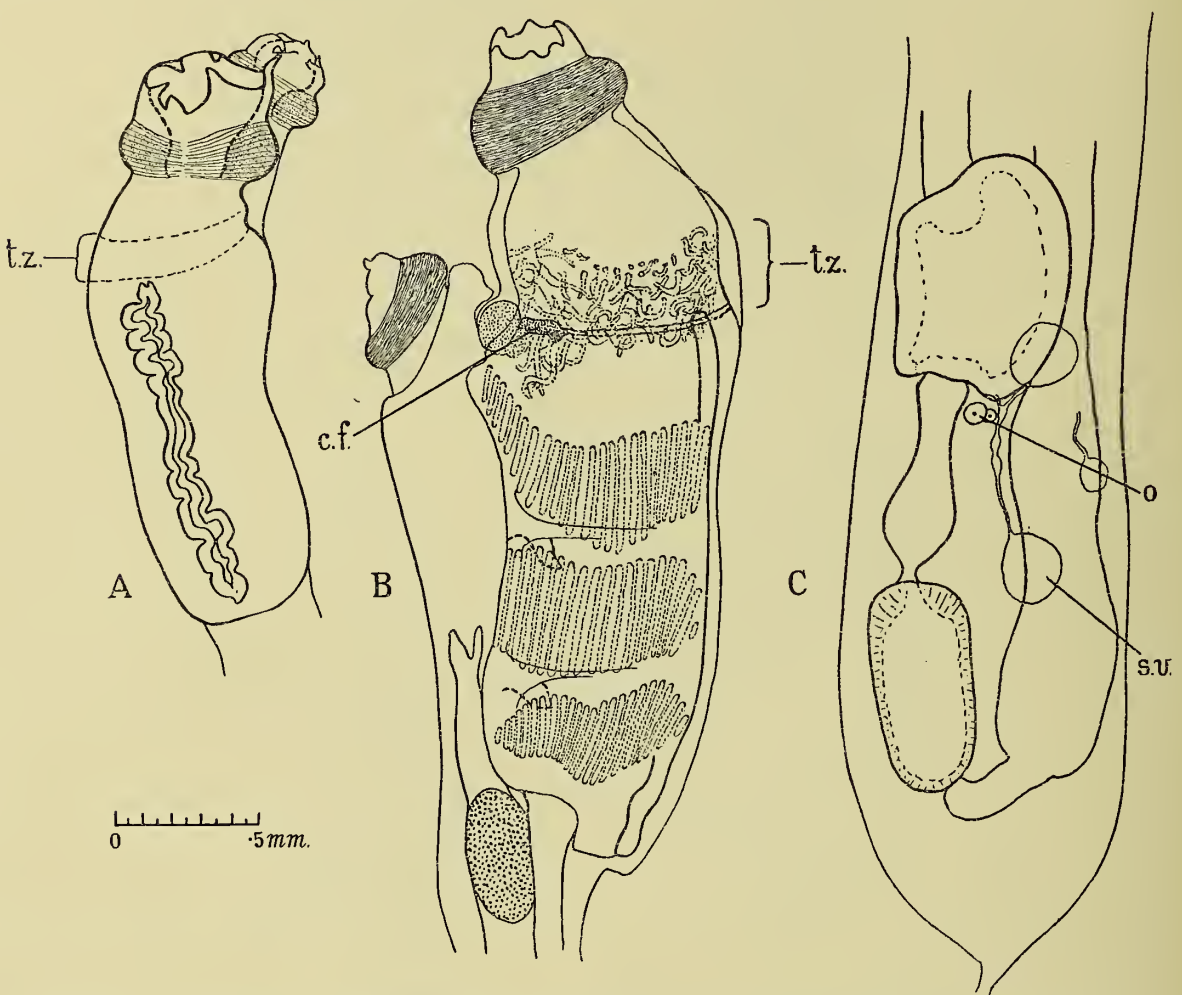


Text-fig. 8.—*Eudistoma ovatum* (Herdman). A and B, Thorax of two zooids from one colony from Cape Boileau. Musculature omitted. C, Outline of colony from Barrier Reef. *c.f.*, ciliated funnel. *t.z.*, tentacular zone.

E. ovatum. The colonies are smaller and, owing to the more numerous sand-grains in the test, harder than those of *E. ovatum*. The broad distal end is flattened and wrinkled. The zooids adhere more closely to the test than in *E. ovatum*. They are not numerous and are much contracted. The one figured (Text-fig. 7 D) is 6 mm. long. The siphons

appear rather more muscular than those of *E. ovatum* without having a definite sphincter. There are very numerous transverse muscle-bands on the thorax (about 60, but accurate counting is impossible), and 7 (or 8 ?) longitudinal bundles of varying thickness. The thick-walled oval section of the intestine is rather more sharply defined than in *E. ovatum*.

Another Australian *Eudistoma* of the *Psammaplidium* type appears to be identical with *Polycitor* (*Eudistoma*) *angolanus* Michaelsen (1915, p. 452) = *P. paesslerioides* var. *angolanus* Michaelsen (1914, p. 430) from W. Africa. A colony of this species from Cape



TEXT-FIG. 9.—*Eudistoma angolanum* Michaelsen. From Cape Boileau, N.W. Australia. A, Contracted thorax. B and C, Thorax and abdomen of expanded zooid from the same colony. Total length of zooid, 13 mm. Musculature, except sphincters, omitted. (For explanation of lettering, see footnote, p. 73.)

Boileau (B.M. 30.9.23.20), which has had a piece cut off, must have been roughly hemispherical when complete. It is 8 cm. in diameter and 3·5 cm. deep at the centre. It was attached by the central area of the more or less flat basal surface. The foreign particles in the test are less numerous in the upper regions than they are in *E. ovatum*, and there are granules of almost black pigment here and there, but not in sufficient quantity to affect the colour of the colony as a whole. A well-expanded zooid, dissected unbroken from the colony, is 13 mm. long, exclusive of the thread-like continuation of the abdomen,

but the majority are less owing to immaturity or contraction. The very thick band of muscle round each siphon (Text-fig. 9 A, B) is sharply defined, and produces a convexity both inside and outside the siphon. It is not completely circular, being interrupted on the outside, *i. e.* at the point furthest from the other siphon. The atrial siphon may appear longer or shorter than the branchial siphon. The tentacles are numerous and arranged in several rows. As in *E. ovatum* the ciliated funnel forms a conspicuous projection below the central nervous system (Text-figs. 8 A, 9 B, *c.f.*). The stomach is smooth and more or less round. The first part of the intestine is wider posteriorly and is separated by a deep constriction from the second part, which is oval, thick-walled and very clearly defined (Text-fig. 9 C). The next section begins very narrow, widens rather suddenly and narrows very gradually for the rest of its length. The regions of the intestine of *E. ovatum* correspond to these, but are much less sharply defined (Text-fig. 7 A). Another peculiarity of this specimen is the presence of stalked, membranous vesicles beside the intestinal loop (Text-fig. 9 C, *s.v.*). Possibly they are empty testis follicles.

Michaelsen divided *E. angolanum* into two varieties. In its sphincter muscles and the number of longitudinal muscles the Australian form resembles var. *togoense*, but instead of 80, less than 60 transverse muscle-bundles were counted.

The Cape Boileau specimen of *E. angolanum* is clearly identical with the form from N.W. Australia identified by Hartmeyer (1919, p. 105) with *Polycitor amplus* Sluiter (1909, p. 21). Zooids from the same colony as those figured here (Text-fig. 9) resemble Hartmeyer's fig. 54 in the narrowness of the siphons below the sphincter. The appearance of a longitudinal fold on the stomach shown in Hartmeyer's fig. 55 is seen in some zooids, but this is not structural, for sections and well-expanded zooids show that the stomach is smooth, as was recognized by Hartmeyer. Sluiter's figure does not show either of the chief peculiarities of this species, namely the conspicuous muscle-bands on the siphons and the sharply-defined oval section of the intestine, and it seems possible that the Australian form is distinct from *E. amplum*.

There are thus three Australian sandy species of *Eudistoma* known, of which *E. ovatum* and *E. angolanum* are distinguished by the form of the siphons, the intestine and the colony, and the third species, *E. pyriforme*, is in some ways intermediate, but is only known from the rather poor type-specimen, consisting of half of one colony and some small fragments. The differences in size seen in the accompanying figures of these species are not constant, and depend very much on the degree of contraction.

Sigillina deerrata (Sluiter). (Text-fig. 10 A, B.)

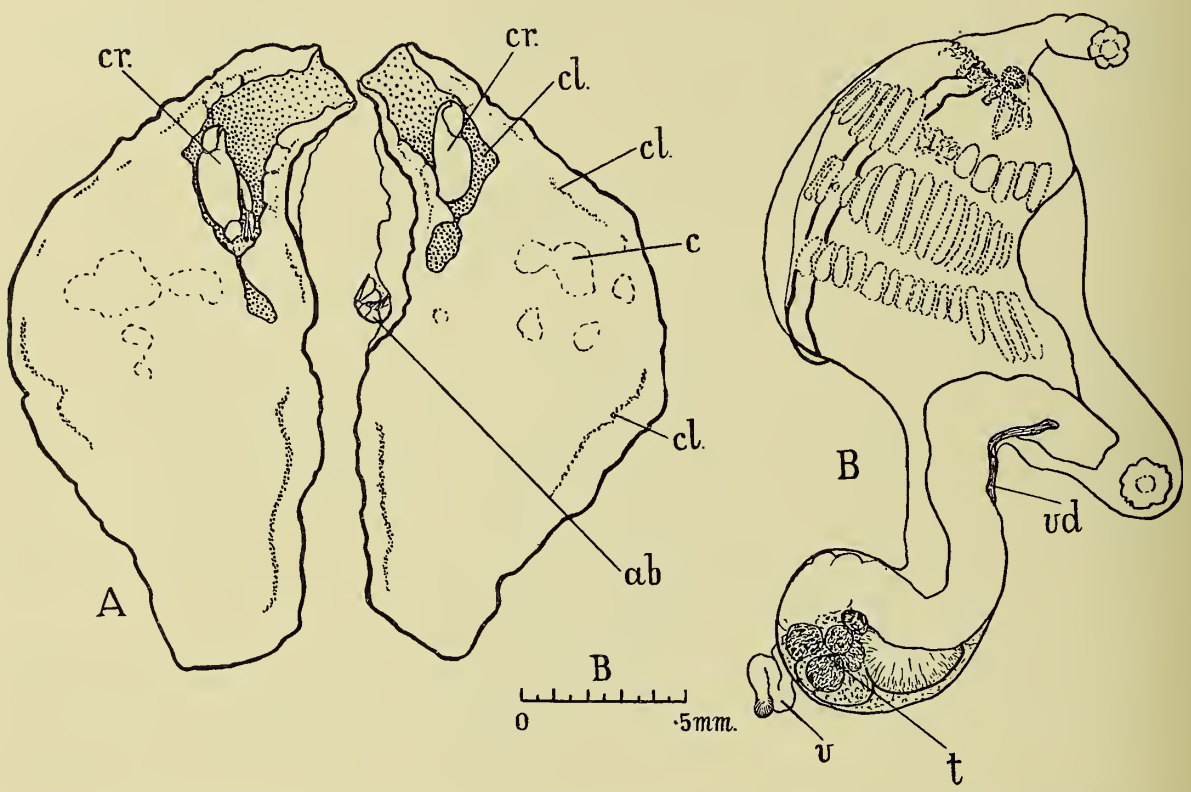
Distoma deerratum Sluiter, 1895, p. 167, pl. vi, figs. 5–7.
Polycitor coalitus Sluiter, 1909, p. 23, pl. ii, fig. 4, pl. vi, fig. 1.
Sigillina (*Polycitor*) *coalita* Michaelsen, 1930, p. 484.

Distribution.—Torres Strait, Malaya (Siboga St. 164).

Occurrence.—St. XVII (3 colonies).

These colonies are all more or less egg-shaped, with a large cloacal orifice at one end (Text-fig. 10 A) and a few scraps of calcareous alga adhering at the other. The largest is 7 cm. high and 5 cm. in diameter at the widest part. The other two are a good deal smaller. The cloacal aperture has a thin vertical rim. The colonies are a pinkish-brown

colour. The zooids are arranged in systems of irregular size and shape, with smaller zooids at the centre and larger towards the outside. The systems are most numerous at the anterior end and are absent from the posterior end. The systems have no cloacal opening to the outside. Their central cavity opens into the cloacal canal, which occupies a layer a little below the surface of the colony, and completely below the zooids. Many of the zooids do not communicate with the common cloaca of their system, their atrial siphon opening into a channel of the test passing directly to the cloacal canal. The centre of the colony consists of firm, but gelatinous test, with a few cavities in its anterior part (Text-fig. 10 A, *c.*). In the smaller colonies this central column extends to the cloacal



TEXT-FIG. 10.—*Sigillina deerrata* (Sluiter). A, Large colony cut in half, showing Crustacea in the cloacal canals. B, Zooid from one of the small colonies. (For explanation of lettering, see footnote, p. 73.)

aperture, forming a sort of plug. In the large colony there is a larger space occupied by the claws of two Decapod Crustaceans. These commensals lie in the cloacal canal at diametrically opposite points. They each have one very large claw, which is extended towards and very nearly reaches the cloacal aperture (Text-fig. 10 A, *cr.*). One of the smaller colonies contains a similar but smaller Crustacean, in a more posterior portion of the cloacal canal. The absence of the plug in the cloacal aperture of the large specimen is probably due to the presence of the Crustacea.

The central column contains calcareous crystals of various form. In the large colony they are linear and arranged in a feathery formation. In the smaller colonies similar elongate crystals are attached to short thick rods.

A zooid is shown in Text-fig. 10 B. The stigmata may be much less irregular than in the one figured. There is a fairly regular network of fine longitudinal and transverse muscles on the thorax. The vascular process varies very much in length.

I have examined the type-specimens of *Distoma deerratum* Sluiter and *Polycitor coalitus* Sluiter, and have satisfied myself that they are synonymous and that the present specimens belong to the same species. The form of the colony is the same in all. The two type-specimens appear to have been somewhat crushed in preservation, giving them the tongue-like shape described by Sluiter. They both have a large terminal cloacal aperture, plugged by the central column of the test. *P. coalitus* has feathery crystals like those of the large Barrier Reef specimen. The wavy-edged stigmata, mentioned by Sluiter in *D. deerratum*, are characteristic of all the specimens. The irregular fourth row of stigmata described in the same species has not been seen. The length of the vascular processes and branchial siphons is extremely variable in all specimens.

From Sluiter's description *D. deerratum* appears to differ from *P. coalitus* in the number of stigmata in a row, the presence of papillae in the branchial siphon and the form of the alimentary canal. Adult zooids of *D. deerratum* have, however, as many stigmata as those of *P. coalitus*, the structure of the alimentary canal is essentially the same and no trace of papillae can be found in the branchial siphon, though in an oblique view the tentacles may give such an impression.

The generic position of this species is obscure. The method of budding, the vascular process (or epicardial post-abdomen), the lobed atrial orifice and the musculature of the thorax clearly show its affinities with *Polycitor*, as was recognized by Sluiter. The cloacal system with a single large cloacal aperture at the apex of the colony and the zooids with long, backwardly curved atrial siphon and small round abdomen afford an interesting parallel with *Didemnopsis*.

In classifying the species of *Polycitor*, Michaelsen (1930, p. 479) regards the number of rows of stigmata as important and reserves *Polycitor* for species with more than three rows. He uses *Sigillina* as a wide genus to cover all the species with three rows pending their re-classification, and defines a number of subgenera of this genus. The cloacal system of *S. deerrata* excludes it from all these subgenera.

Tridemnum cyclops Michaelsen. (Plate II, fig. B; Text-fig. 11.)

Tridemnum cyclops Michaelsen, 1921*a*, p. 19, pl. i, fig. 10.
? *Tridemnum planum* Sluiter, 1909, p. 42, pl. iii, fig. 12, pl. vii, fig. 7; Michaelsen, 1920, p. 6.

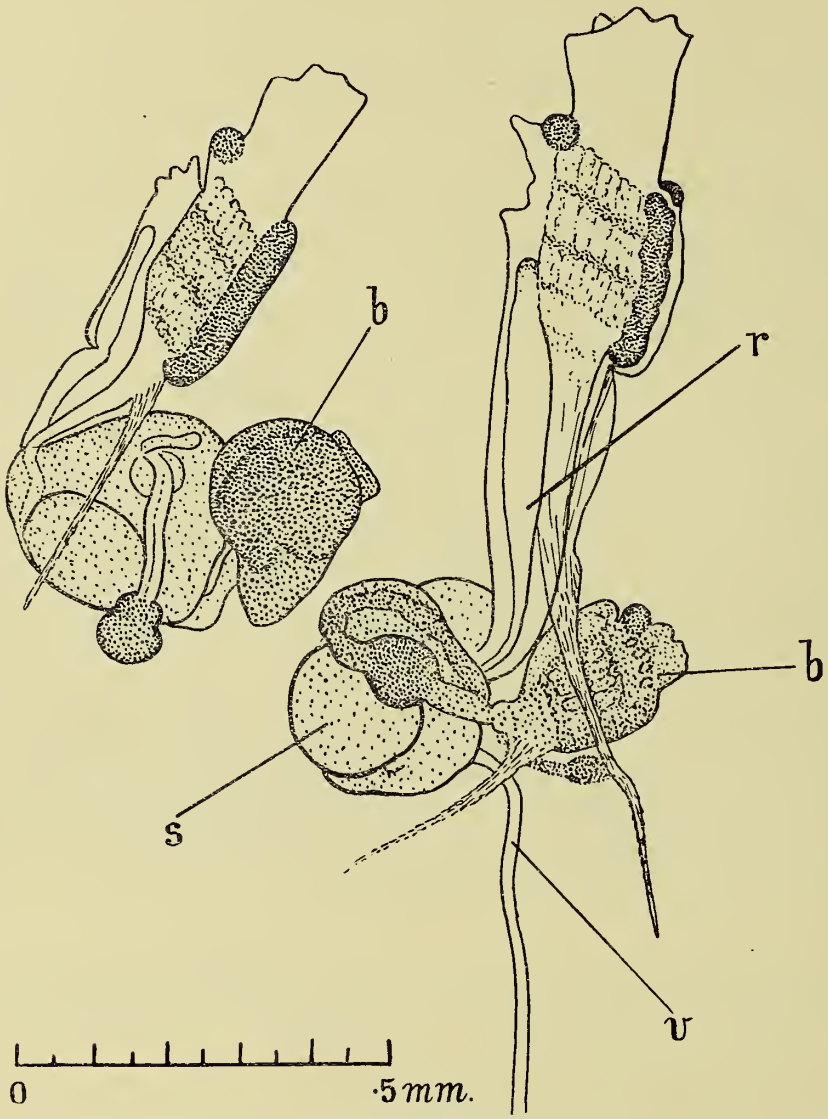
Distribution.—Malaya ? Madagascar.

Occurrence.—G. 3.

The colonies are thicker than Michaelsen's, being ·2–·3 mm. thick and having a cushion-like appearance. They are pale buff with white edges of very variable width. They agree in the distribution of spicules, excretory granules and bladder-cells and in the presence of numerous spherical bodies in the cloacal canals. Dr. C. M. Yonge finds that these bodies are zooxanthellae. The spicules are larger than described by Michaelsen. There is very little pigmentation, even the black cap on the endostyle being very rarely present. The zooids are similar in general form. The branchial siphon is longer and thicker and its dorsal lobe tends to project. The atrial siphon is usually as described by

Michaelsen, but in some (young ?) zooids it is more anterior, tubular and lobed (Text-fig. 11, smaller zooid).

The cloacal canals and the thoracic portions of the zooids occupy the region between the two layers of spicules, and in a hand-section such as that figured (Plate II, fig. B) the zooxanthellae (*z.*) can be seen to be massed in great numbers in this region. They are not



TEXT-FIG. 11.—*Tridemnum cyclops* Michaelsen. Two zooids in their natural juxtaposition. (For explanation of lettering, see footnote, p. 73.)

found elsewhere. Dr. Yonge finds that they are not of the same kind as those in *Diplosoma virens.*

T. cyclops may prove to be synonymous with *T. planum* Sluiter, which resembles it in many ways. Spicules and bladder-cells are similarly distributed. The spicules resemble those of the Barrier Reef specimens in size. The atrial siphon is longer and unlobed. The zooxanthellae are not mentioned unless, as seems possible, they are referred to as pigment-cells.

Trididemnum savignii (Herdman).

Didemnum savignii Herdman, 1886, p. 261, pl. xxxiv, figs. 1–5.
Trididemnum savignii Van Name, 1921, p. 314, text-figs. 7–9 (synonymy); 1924, p. 25; Sluiter, 1927, p. 89.
? *Didemnum areolatum* Herdman, 1906, p. 337, pl. viii, figs. 26, 27.

Distribution.—Indian Ocean, Morocco, W. Indies.

Occurrence.—St. XIX (1 colony).

This colony forms an irregular incrustation measuring 5·5 by 2 cm. and 1–2 mm. thick. It is a dirty, rather speckled, grey colour, owing to the irregular distribution of the spicules in the upper layers of the test, the yellowish-brown colour of the zooids and the grey of the test. There is a narrow grey border free from zooids and spicules. The cloacal apertures are round and shallow and 2–3 mm. in diameter. They are conspicuous owing to the narrow black rim of their orifice, and to a dense layer of spicules in the floor of the cloacal canal showing through the opening. The test consists of three layers. The layer above the cloacal canals contains scattered spicules in dense clumps and singly. The clumps do not coincide with the branchial apertures. Below the cloacal canals, forming their floor, is a thin layer of very closely placed spicules. This layer is at the level of the neck of the zooids. Below this spicules are extremely rare and the test is packed with bladder cells. The spicules resemble those figured by Van Name. The largest are ·08 mm. in diameter. Besides the black pigment in the rim of the cloacal orifice, there is pigment in the test in the interstices of the bladder-cells and in the mantle on thorax and abdomen.

The branchial and atrial siphons are short and lobed. The thorax is smaller than the abdomen. The neck is narrow, but not very long, and the abdomen is turned sideways. The retractor is about as long as the abdomen. Owing to pigmentation the details of the internal structure cannot readily be made out. There are three rows of stigmata. The stomach is long and oval with cardiac and pyloric inpushings. No reproductive organs were seen.

Examination of the type of *Didemnum areolatum* Herdman (B.M. 07.8.30.36) shows that it agrees with the present specimen in the shape, size and distribution of the spicules, except that the largest are even larger. It differs in pigmentation; the general colour is a yellowish brown, due to brown pigment-granules which are scattered in the test below the spicule layer, and are concentrated above the spicules in the floor of the cloacal canals. The zooids are also yellowish brown in colour, with some brown pigment on the branchial siphon and the thoracic tubercles. The blackish pigment of the Barrier Reef specimen is absent. The cloacal apertures are visible. The retractor is rather short. These differences are slight in themselves and fall well within the range of variation attributed to *T. savignii*, with which I think *D. areolatum* is synonymous. Herdman's figures are misleading, giving no indication of the arrangement of the spicules in a dense layer below the cloacal canals, nor that the bladder-cells are closely packed throughout the part below the spicule layer, although both of these are characteristic features of the type-specimen. A good deal is made of the arrangement of the zooids in systems. This effect is much less definite than fig. 26 would suggest, and in basal view, where the zooids are much more distinctly visible, they can be seen arranged in sinuous lines. The testis is a single follicle round which the vas deferens makes about eight turns.

In the pigmentation of the zooids and particularly of the cloacal apertures, the Barrier Reef specimen of *T. savignii* resembles the encrusting specimen of *Didemnum ramosum* Sluiter (1909, p. 63) from Sailus Ketjil, which, however, had 4 rows of stigmata.

Tridemnum natalense Michaelsen.

Tridemnum natalense Michaelsen, 1920, p. 3, text-fig. 1.

Distribution.—Natal.

Occurrence.—St. XIX (1 colony).

This colony agrees with *Tridemnum natalense* Mich. except in the distribution of the spicules, which are irregularly scattered in small clumps and form no continuous layer. The branchial sac usually agrees with Michaelsen's figure, but occasionally the stigmata are considerably longer. Only female reproductive organs were seen. Michaelsen found male gonads only.

Van Name (1921, p. 314) gave this as a doubtful synonym of *T. savignii*. As it is distinguished by the distribution of spicules and pigment from the specimen of *T. savignii* from the same locality on the Barrier Reef, it has seemed best to treat it as distinct for the present.

Leptoclinides reticulatus (Sluiter).

Didemnum reticulatum Sluiter, 1909, p. 60.
Leptoclinides sparsus Michaelsen, 1924, p. 336, text-fig. 13.

Distribution.—New Zealand, Malaya (Siboga, St. 37).

Occurrence.—St. XII (1 colony).

It is surprising to find, on examining the type, that *D. reticulatum* is a *Leptoclinides*. The zooids are of the characteristic form with a backwardly-directed atrial siphon opening into cloacal canals that run below the zooids, rather conspicuous longitudinal musculature on the thorax and the characteristic thoracic tubercles. Mature gonads were not seen, but the testis appears to be divided. The test has a layer of bladder-cells at the surface. Below this is a zone containing spicules, which are most numerous in its upper part. This zone has irregular spindle-shaped or branched pigment-cells. The pigment-cells are chiefly congregated just below the bladder-cell layer, but are found here and there lower down. Below the spicule-zone the test consists almost entirely of bladder-cells, but a few spicules are found in this part, especially at the basal surface. The zooids and cloacal canals occupy the spicule zone. The spicules are, on the average, ·03 mm. in diameter, and may attain ·04 mm. Thus neither the spicules nor the pigment-cells of the specimen from St. 37, which is regarded as the type, agree perfectly with Sluiter's description, and one can only assume that some of the specimens from other localities were different.

The Barrier Reef specimen differs from the type in the greater quantity of pigment, pigment-cells being found throughout the bladder-cell and spicule layers. This gives the whole colony a darker appearance, the borders being dark grey and the central parts speckled grey and black. In the type the central parts may be grey and black, or white and black, but the borders are always white. No cloacal openings were seen in the Barrier Reef specimen. They are rather conspicuous in the type, being round or oval with a thin border free from spicules and pigment-cells. In the preserved material this border

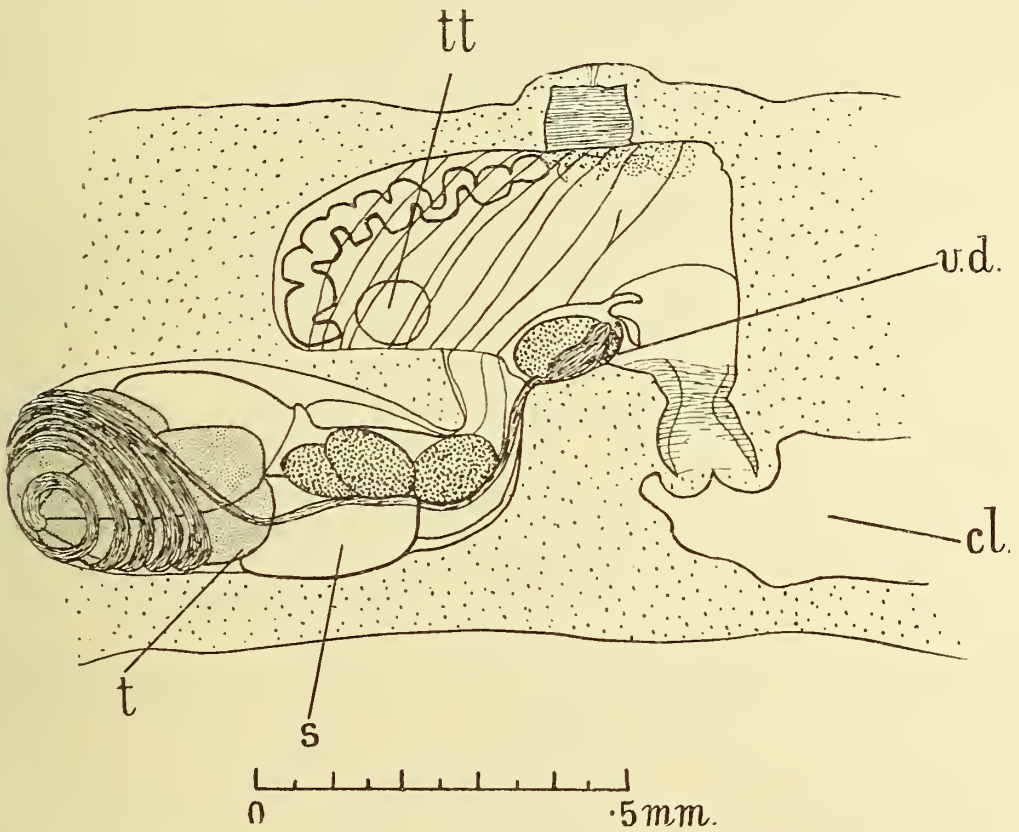
forms a frilled edge to the aperture, but it looks as if it would stand up as a collar in the living animal.

The agreement of this species with Michaelsen's full description of *L. sparsus* leaves me with no doubt that he had the same species.

Leptoclinides lissus sp. n. (Text-fig. 12.)

Occurrence.—St. XVI (1 colony).

This specimen forms a band 3 cm. wide round a worm-tube. It is less than 1 mm. thick, except at a few points where it attains 2 mm. It is smooth, white and opaque.



Text-fig. 12.—One zooid of *Leptoclinides lissus* sp. n. (For explanation of lettering, see footnote, p. 73.)

The zooids are visible to the naked eye as light grey patches. Under considerable magnification the branchial orifices of decalcified and stained pieces can be seen to have lobes of very unequal size, as figured for *L. diemenensis* (Michaelsen, 1924, p. 331), but in a surface view of the undecalcified colony the conspicuous features are three groups of two or three spicules surrounded by a muscular ring. Bladder-cells are rare and do not form a definite layer. The spicules are mostly about ·04–·05 mm. in diameter, regularly stellate with pointed rays. They are rather numerous throughout the zone occupied by the zooids, but are rare in the basal layer. They are very evenly and closely distributed in the surface layer. The abdomen turns sharply sideways (Text-fig. 12), and the atrial siphon is directed downwards to the cloacal canal which runs near the base of the colony. The

siphons are both long, the length varying somewhat, apparently according to the degree of contraction. No vascular processes were seen. The thoracic tubercles are of the form characteristic of *Leptoclinides*. They are ·1–·2 mm. in diameter, and lie near the middle of the posterior end of the thorax. There are about 9 longitudinal muscle-bands on each side of the thorax. The branchial sac has 4 rows of long, oval stigmata and about 12 stigmata in a row. There are about 16 tentacles. As many as 7 testis follicles have been counted and the vas deferens makes 6 turns.

Remarks.—This species belongs to the southern group of species of *Leptoclinides*, differing from the northern *L. faeröensis* Bjerkan in their divided testis. It is very closely allied to *L. diemenensis* Michaelsen (1924, p. 331), only differing in the smoothness, whiteness and opacity of the colony and in the absence of an outer layer of bladder-cells. Probably when more is known of their range of variation these species will be found to be synonymous; at present it seems best to treat them as distinct.

Didemnum candidum Savigny. (Plate II, fig. A; Text-fig. 13.)

Didemnum candidum Savigny, 1816, pp. 14, 194, pl. iv, fig. 3, pl. xx, fig. 1; Hartmeyer, 1915, p. 419, text-figs. 13, 14; Michaelsen, 1919, p. 18; Van Name, 1921, p. 322, figs. 16–18, 20–25; Michaelsen, 1924, p. 358 (synonymy); Van Name, 1924, p. 25.

Distribution.—New Zealand, Indian Ocean, Atlantic.

Occurrence.—Low Isles: Thalamita Flat (pink and white forms), R.C. (pink form), Dredge: St. XIX, XXI, XXII.

Two characteristic specimens of *Didemnum candidum* were dredged growing on a sponge at St. XXI and very small colonies on other Tunicates at St. XIX and XXII. The spicules are stellate and are slightly more numerous in the upper layers. The largest colony is irregular in shape. It measures 5 cm. × 1·5 cm., and is about 1·5 mm. thick. They are all white.

The shore Didemnids of similar type have burr-like spicules with numerous fine rays, such as were found by Van Name (1921) in *D. candidum*. The collector, who was an experienced systematist, found that they were of two clearly defined kinds, differing, among other things, in colour, one kind being white, the other pink. He describes the white colonies as being "generally larger and more winding," and differing in texture. He says that the colours of both were quite constant and did not suggest colour varieties.

In the preserved material the white form is thin. It has fewer spicules in the lower layers. There is a darkly pigmented epithelium over the abdomen and some pigment on the thorax. The cloacal apertures are small and inconspicuous, and in section a few large bladder-cells are seen at the surface. The pink colonies from the Thalamita Flat are small and cushion-like (Plate II, fig. A). The colour is lodged in the test, which is pink, and in the zooids, which are red. The cloacal apertures are rather large and shallow. The specimens of the pink type from R.C. are, however, intermediate. The colonies are thin and white, when preserved, as in the white form, but the spicules are densely distributed throughout as in the pink. The cloacal apertures are slit-like.

No essential difference could be detected in the zooids of any of these colonies. The branchial siphon is broader than high, with six shallow, pointed lobes. The thorax is

about as wide as high with a simple atrial opening. The thoracic tubercle is external and lies at about the level of the third row of stigmata. The branchial sac has four rows of stigmata, and about eight stigmata in a row. There is a pointed retractor which is not attached to the neck. The œsophagus is sharply constricted at about the middle of the neck. The abdomen is slightly larger than the thorax. There is a more or less oval stomach. The intestine is in three sections, separated by constrictions. The first (" nachmagen ") is cylindrical, with a sudden expansion behind. The second (" drusen-magen ") is oval and the third long and slightly tapering. The rectum is thin-walled. The ovary and testis lie beside the intestine. The testis consists of a single follicle, round which the vas deferens makes five turns.

Such differences in the zooids as exist appear to depend either on the thickness of the colony or on the state of contraction of the digestive tube. In thin colonies the abdomen is turned sharply to one side, while in thick ones it hangs straight down. The stomach may have both cardiac and pyloric inpushings, or one only, or neither, and the parts of the intestine may be wide or narrow. These differences may appear in the same colony (Text-fig. 13). In the zooids from the pink form the thoracic tubercles are slightly more conspicuous and more stalked than in the other specimens, but the whole thorax is less shrivelled, so the difference is probably only apparent.

Superficially, the pink form might be thought to be *L. densum* Nott (1892, p. 311). This species differs, however, in the spicules, whose rays are few and very blunt, in the longer branchial siphon and in the divided testis. Michaelsen (1924, p. 354) re-discovered Nott's species and confirmed these characteristics. He regards *D. densum* as synonymous with *D. albidum* (Verrill, 1871, p. 446).

To sum up, the shore specimens attributed to *D. candidum* all differ from the dredged specimens in their burr-like spicules. When alive they fell into two groups, distinguished by colour, texture, etc., but the only character which constantly distinguishes these same groups in preserved material is the distribution of spicules. These are less numerous in the lower layers of the white group and uniformly dense throughout in the pink. The zooids are very similar in all. They all fall within the range of variation attributed to *D. candidum* by Van Name (1921), and Michaelsen (1924) expresses his agreement with Van Name's view. On the other hand, a species (*D. densum*), somewhat resembling the pink form externally, differs in internal structure.

At present, therefore, there seems to be no alternative but to treat all the Barrier Reef specimens as one species. The observations on the living material are, however, of great importance, and point to the existence of differences which are not expressed by the present systematic treatment of the Didemnidae.

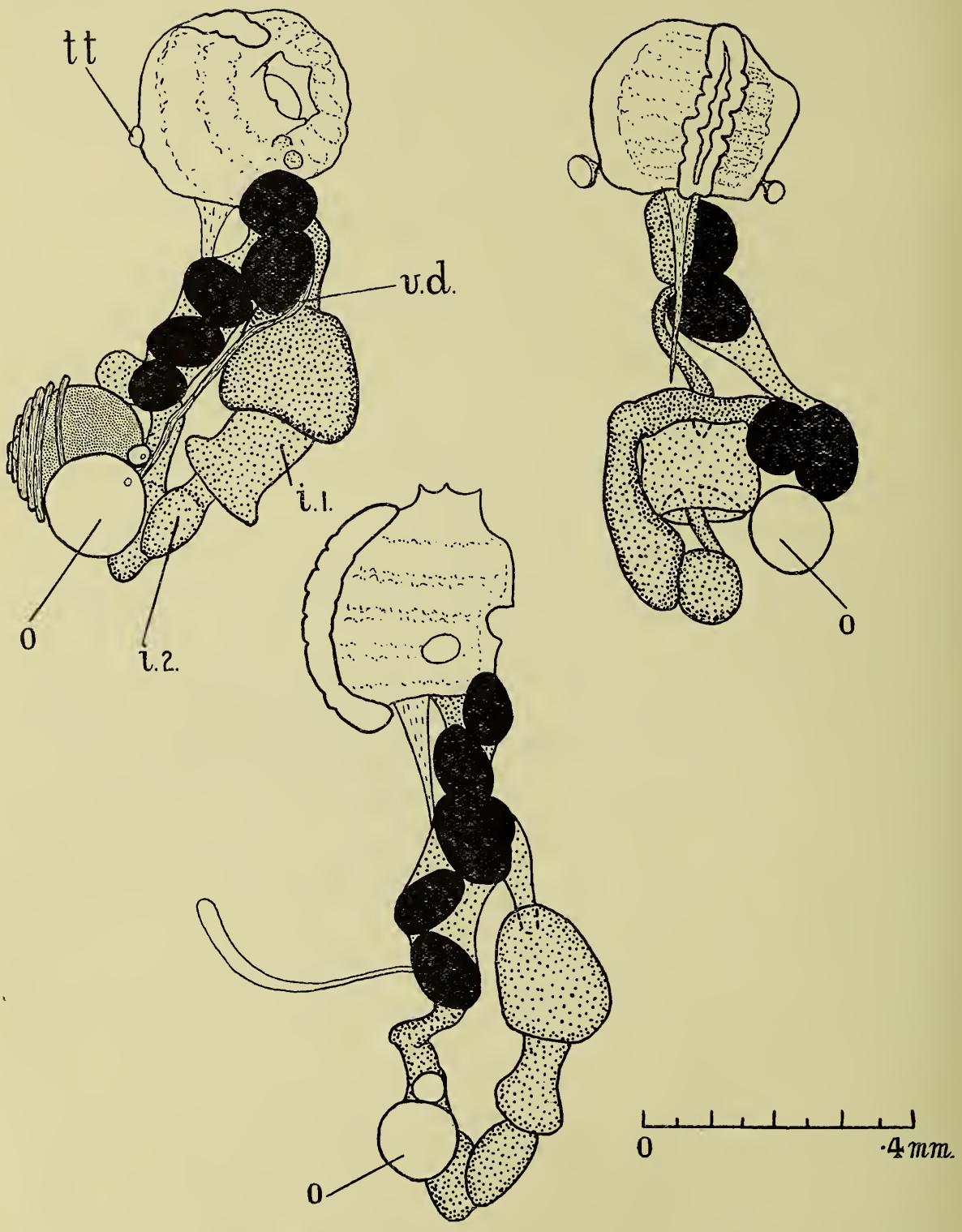
Didemnum psamathodes var. *skeati* (Sollas).

Hypurgon skeati Sollas, 1903, p. 729, pls. xxxiv, xxxv.
Didemnum psammatodes var. *skeati* Michaelsen, 1920, pp. 22, 27 (synonymy).

Distribution.—Malaya, Indian Ocean, Gold Coast ?

Occurrence.—Thalamita Flat.

These specimens correspond to Sollas' description of var. *skeati*. They differ from the typical form of Sluiter (1895, p. 171) in having a cluster of spicules round each branchial opening, and few, if any, in the rest of the test.



Text-fig. 13.—*Didemnum candidum* Savigny (pink form). Three zooids from the same colony. (For explanation of lettering, see footnote, p. 73.)

Didemnum voeltzkowi Michaelsen.

Didemnum voeltzkowi Michaelsen, 1920, p. 54, text-fig. 6.

Distribution.—Madagascar.

Occurrence.—Sand Flat, A4.

These specimens agree in most points with Michaelsen's description of *D. voeltzkowi*. The spicules are uniformly and densely distributed except in the region of the lowest cloacal canals, where they may be slightly less numerous. No central cavity was seen in them. The colonies from A4 are encrusting. Those from the Sand Flat are rather large irregular pieces with a smooth white basal surface which appears only to have been attached here and there. The largest measures 60 mm. × 30 mm. The zooids are very well expanded and are 1·5 mm. long. The branchial aperture is not lobed. The anus is beside the posterior end of the thorax. Otherwise their agreement with Michaelsen's description is exact.

The spherical bodies described by Michaelsen are very numerous round the branchial sac. Dr. C. M. Yonge finds that they are zooxanthellae. The general arrangement is that shown by Michaelsen (1920, p. 52, Text-fig. 5) in *D. bistratum*, but the zooxanthellae tend to be arranged in a single layer on the surface of the branchial sac and its projecting laminae, and they may be so numerous as to fill the rectangular spaces formed by these laminae as seen in cross-section. Dr. Yonge finds that the zooxanthellae are not of the same kind as those in *Diplosoma virens*.

D. voeltzkowi was found at Madagascar. Two species (*L. bistratum* Sluiter, 1905, p. 18, and *D. patella* Gottschaldt, 1898, p. 651) of the *D. bistratum*-group of Michaelsen (1920) are known from Malaya, but they do not agree with the Australian specimens as closely as does *D. voeltzkowi*.

D. voeltzkowi superficially resembles *Leptoclinum tonga* Herdman (1886, p. 269), from Tongatabu. They agree in the shape of the colony, the absence of bladder-cells and the distribution of spicules, in the long thorax with four rows of long stigmata and the relatively short round abdomen, and in the position of the thoracic tubercles. Examination of Herdman's type shows that they differ in many ways. In *L. tonga* the surface of the colony is smooth. There are no cloacal canals below the zooids. The spicules have fewer longer rays (Herdman, pl. xxxv, fig. 4). Each zooid has a very long retractor, extending beyond the abdomen for more than the length of the whole zooid. The zooids are much less numerous. The atrial opening is not remarkably extensive, and there are no zooxanthellæ. The testis is slightly lobed, and the vas deferens makes five turns round it.

Didemnum chartaceum Sluiter. (Text-fig. 14 A, B.)

Didemnum chartaceum Sluiter, 1909, p. 57.

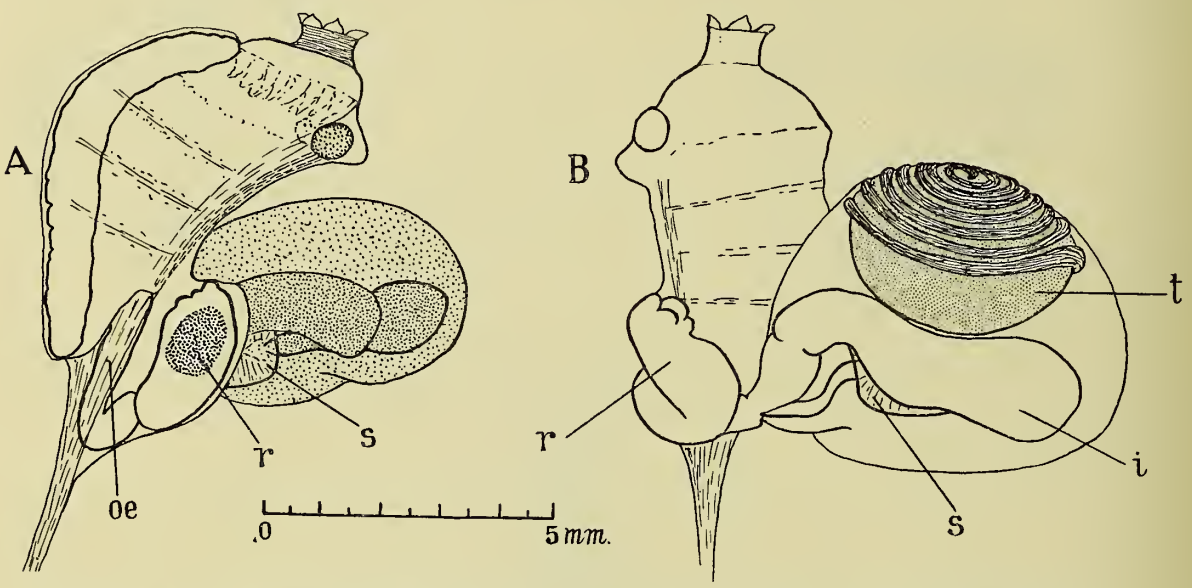
Distribution.—Flores (Siboga, St. 50).

Occurrence.—St. XVI (1 colony).

This colony covers the back of a small Dromiid crab, only leaving the ventral surface and appendages free. It is 2·5 mm. thick at the thickest point. The zooids are evenly

distributed and show as darker patches on the surface. There are three shallow, round cloacal apertures, conspicuous owing to the absence of spicules in their floor. The surface layer consists of bladder-cells. Below this there is a thin layer of closely placed spicules. The main thickness of the test consists of bladder-cells and the basal layer contains some spicules, but they are not so thickly distributed as in the upper spicule layer. The spicules have rather numerous blunt rays and the majority are ·03 mm. in diameter.

The zooids occupy the upper half of the colony, but their retractors extend straight down into the lower half and may nearly reach the base. There are knobbed vascular processes. The abdomen is slightly larger than the thorax and placed at right angles to it. The branchial siphon is about as wide as high and has six small pointed lobes. The atrial opening is a simple hole. The thorax has longitudinal muscle-bands, the strongest of which are dorsal, and there are transverse muscles over the transverse bars. There are four



Text-fig. 14.—*Didemnum chartaceum* Sluiter. Two views of zooids from the type-specimen. A, Seen from the left. Abdomen shaded. B, Composite drawing of a zooid seen from the right. (For explanation of lettering, see footnote, p. 73.)

rows of stigmata. The dorsal languets are large. The thoracic tubercles contain large quantities of spicules and are very conspicuous in undecalcified material. They occupy the middle of each side of the thorax and project outwards. The testis consists of one large follicle, round which the vas deferens makes eight turns. It lies beside the intestinal loop.

Examination of the type of *D. chartaceum* (Text-fig. 14 A, B) shows that it agrees very closely with this specimen. It differs in the form of the colony, which in the Barrier Reef specimen is clearly related to its position on the back of a crab. No vascular processes were seen in the type, and it differs in colour. The tissues of the Barrier Reef colony are of a reddish-purple colour, of such persistence and intensity that unstained microscopic preparations have all the appearance of having been stained. It does not look like a natural pigmentation, for it is diffused through all the tissues both of zooids and test.

The crab and some sponges from the same bottle are the same colour, and the original label is somewhat stained. All these points lead me to suspect that the colour is derived from some other organism bottled with them.

Didemnum jedanense Sluiter.

Didemnum jedanensis, Sluiter, 1909, p. 59.

Distribution.—Malaya.

Occurrence.—St. XII (1 colony on a Gastropod), XIX (1 colony on weed).

I have examined original material of this species from three of the four stations at which it was obtained. All agree in having a surface layer of bladder-cells without spicules, and below this a zone with spicules, the spicules becoming less numerous basally where there are many bladder-cells. They all have pigment-cells in the upper layers, giving a streaked or mottled appearance to the colony as a whole. The pigment is purplish brown in spirit. The cloacal system is chiefly at the level of the thorax, but has channels extending between and below the zooids. The zooids have a rather large abdomen and a long retractor, extending beyond the end of the abdomen. The thorax has musculature on the transverse bars, a pair of strong longitudinal muscle-bundles on the dorsal edge, and fine longitudinal strands over the rest.

In other ways there is a certain amount of difference between the specimens. The specimen from St. 303 shows certain peculiarities which I interpret as signs of old age in the colony. The vas deferens appears to be degenerating. It is inflated and composed of rather coarse, deeply-staining tissue, and only forms one turn. No trace of the testis can be seen. The test contains excretory granules and fæcal pellets in its lower layers and much pigment throughout. There are very few zooids and the cloacal system is of correspondingly small extent. The spicules are large with many blunt rays.

The specimens from the other two localities are therefore more important representatives of the species and I choose that from St. 89, the first on Sluiter's list, as the type. It differs from that from St. 273 in its rather smaller spicules with more numerous, finer rays. The spicules from St. 273 are larger, some being as much as ·03 mm. in diameter, and very regularly stellate. In the type the pigment-cells are elongate and distributed throughout the zooid-containing region of the test. In the specimen from St. 273 they are more or less round and only found in the bladder-cell layer. The zooids are visible as grey dots at the surface of the colony from St. 273, and are less conspicuous in the type. Some zooids in the type are well expanded and the thorax then appears considerably longer than broad, with large stigmata. More contracted zooids do not differ noticeably from those from other specimens. The vas deferens makes 6–8 turns round the testis, which may be flat or spherical in different zooids of the same colony. Vascular processes with knobbed ends have been seen in the type, but not in the specimen from St. 273.

Two specimens from the Barrier Reef agree with these specimens in the presence of pigment-cells, the distribution of bladder-cells and spicules, the tridimensional cloacal system, the general form of the zooids, the long retractor and the musculature of the thorax. One (St. XII) resembles the type in its inconspicuous zooids. The other, like that from St. 273, has zooids clearly visible as dots on the surface. This specimen has large spherical pigment-cells, ·05 mm. in diameter, with the pigment-granules arranged

peripherally. They appear distinctive, but the other specimen shows gradations between these and the smaller, less regular ones of the specimen from St. 273. The spicules are rather smaller than those of any of the original specimens. A few are ·025 mm. in diameter, but most are smaller. They have rather numerous fine rays. Knobbed vascular processes are present in the specimen from St. XIX, but have not been seen in that from St. XII. The differences, both here and in the types, in the occurrence of vascular processes may depend on the part of the colony cut, as they were only seen at the edge. No gonads were seen.

This species as understood by Sluiter has a considerable range of variation which covers the characteristics of the Barrier Reef specimens, and it has seemed best to identify them with it for the present.

Didemnum (*Polysyncraton*) *magnetae* sp. n. (Text-fig. 15).

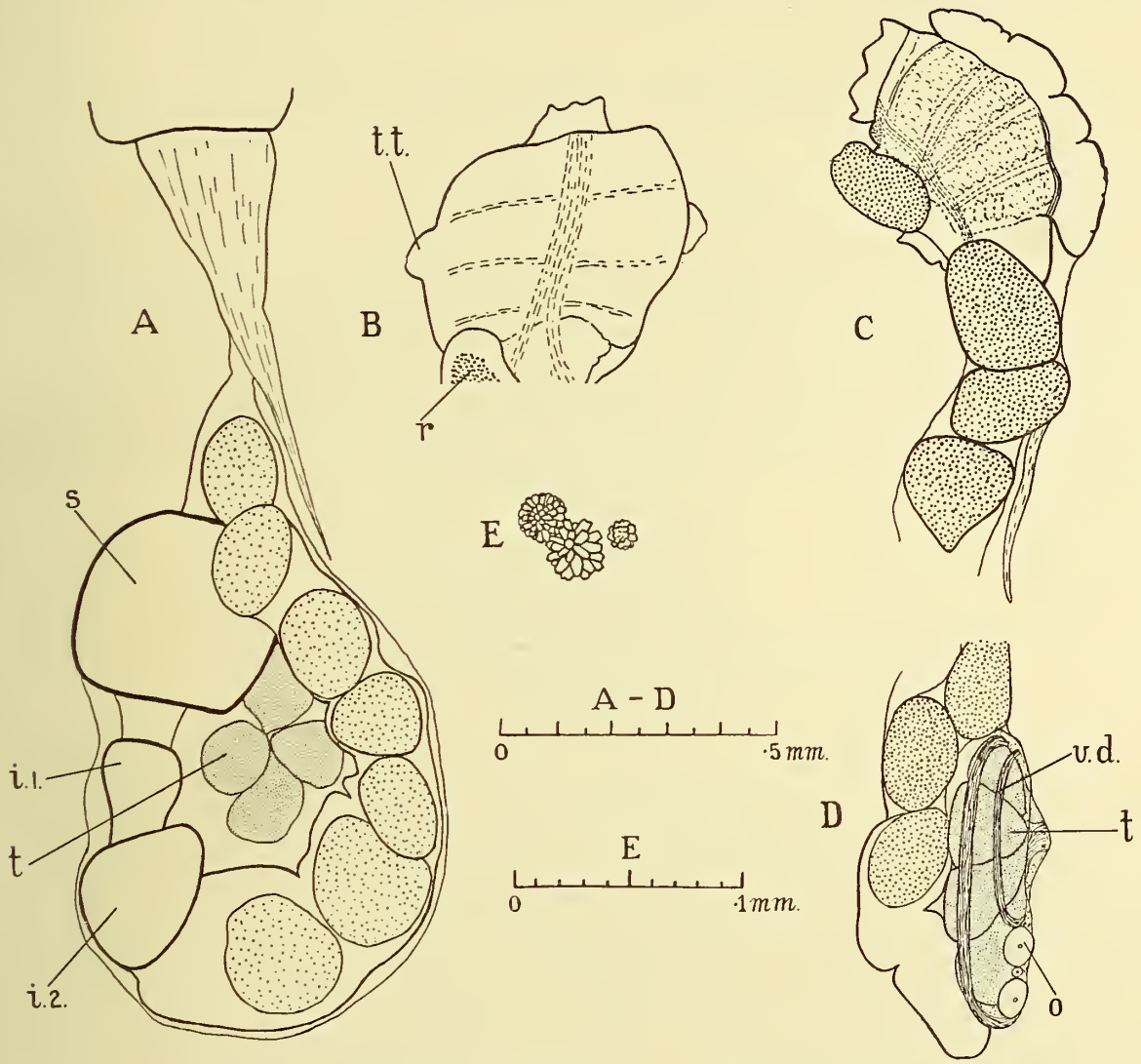
Occurrence.—St. XXIII (1 colony).

The colony appears to have been loosely attached to an irregular substratum. It is on the average, 3 mm. thick, and of flexible, leathery consistency. The zooids are yellowish grey. They are arranged in double rows, which form a network over the surface of the colony, conspicuous to the naked eye. The surface areas between the rows of zooids contain many spicules and are white and slightly prominent. There are two conical projections of the surface of the colony, each with a rather large, round aperture at the summit. One contains a tube of fine mud which was presumably made by some commensal animal, but is now empty. The other contains shell fragments, etc. The hollow centres of these cones are traversed by strands of test containing scattered spicules. No other cloacal apertures were seen.

In vertical section the thin layer of test above the cloacal canals is seen to contain spicules and bladder-cells in quantities varying according to the region cut. In some parts there is a definite layer of spicules here. Below the cloacal canals, and forming their floor, is a thin layer of densely packed bladder-cells, free from spicules. Spicules are most densely packed just below this layer. They become rather less numerous towards the basal surface and some bladder-cells are found. There is a thin basal layer with many spicules, giving a smooth, white under-surface. No pigment-cells have been seen. There are clusters of excretory granules in the lower layers, and in many parts of the test faecal pellets are very numerous (" Hypurgon-condition "). The largest spicules are less than ·03 mm. in diameter. They have rather numerous blunt rays (Text-fig. 15 E).

The zooids are about 1·5 mm. long. The abdomen forms nearly half this length and the neck is nearly as long as the thorax. The neck is usually constricted just behind the middle. The retractor varies in length, but never extends beyond the abdomen. The extent to which it is attached to the neck is very variable. One or more vascular processes may spring from the posterior end of the neck, and may have knobbed ends. The branchial siphon is much broader than long when relaxed, slightly longer than broad when contracted (Text-figs. 15 B, C). The upper and lower edges of the atrial opening are more prominent than the sides. There are longitudinal thoracic muscle-bands, of which the most conspicuous on each side is dorsal (Text-fig. 15 B, C), and there are muscles on the transverse bars. There are 4 rows of stigmata, and about 10 in a row, but accurate counting is impossible. The dorsal languets are large. The thoracic tubercle lies over

the second row of stigmata, rather nearer the dorsal than the ventral edge of the thorax. It projects into the test and appears to have a small round aperture at its apex (Text-fig. 15 B). The alimentary canal forms a long narrow loop (Text-fig. 15A). The stomach is large and its long axis is placed longitudinally. The first two sections of the intestine are directed straight backwards. The second section is thicker-walled than the first, and after it the intestine turns sharply forward. The gonads are beside the intestinal loop (Text-fig.



Text-fig. 15.—*Didemnum* (*Polysyncraton*) *magnetae* sp. n. A, Neck and abdomen. B, Dorsal view of thorax. C, Thorax seen from the right. D, Tip of abdomen. E, Spicules. (For explanation of lettering, see footnote, p. 73.)

15D). The testis consists of 5–7 follicles, more or less closely packed according to their size. The vas deferens makes $1\frac{1}{2}$–2 turns. The ovary lies close to the testis on its outer surface.

Remarks.—This species is allied to *P. tubiporae* Michaelsen (1920, p. 9). They resemble each other in the arrangement of the zooids, the general structure of the test, and the size and shape of the spicules. Both have a layer of test which is free from spicules

below the cloacal canals. The zooids are similar in size and shape, the proportions of thorax, neck and abdomen being characteristic. In both the testis is in the intestinal loop, with the ovary closely pressed to its outer surface. *P. magnetae* differs from *P. tubiporae* in the following points : There is no outer layer of bladder-cells, but this may have been lost, the colony having a rather worn appearance. The thoracic tubercles project outwards and have a small round aperture. The intestine is definitely divided into sections. The vas deferens only makes $1\frac{1}{2}$–2 turns round the testis.

Diplosoma spongiforme (Giard) var. ? Michaelsen.

Diplosoma spongiforme var.? Michaelsen, 1930, p. 529.

Distribution.—S.W. Australia, Indian Ocean ?

Occurrence.—St. XIX (1 colony).

This specimen is a true *Diplosoma* of the *D. spongiforme* type. The colony is dappled black and light brown, owing to the presence of black pigment in the body-wall of some groups of zooids and its absence from others. In the pigmented zooids both thorax and abdomen are black and consequently opaque.

There can be very little doubt that this specimen belongs to the same species as Michaelsen's from S.W. Australia, but, as he has pointed out, it is at present impossible to determine its relationship to *D. spongiforme* and other similar forms.

Diplosoma virens (Hartmeyer). (Plate III, figs. A and B ; Text-fig. 16.)

Leptoclinum virens Hartmeyer, 1909, p. 1456, nom. n. for
Diplosoma viride Herdman, 1906, p. 341, pl. viii, figs. 34–40, pl. ix, fig. 6.
non *Leptoclinum viride* Herdman, 1906, p. 340.

Distribution.—Ceylon.

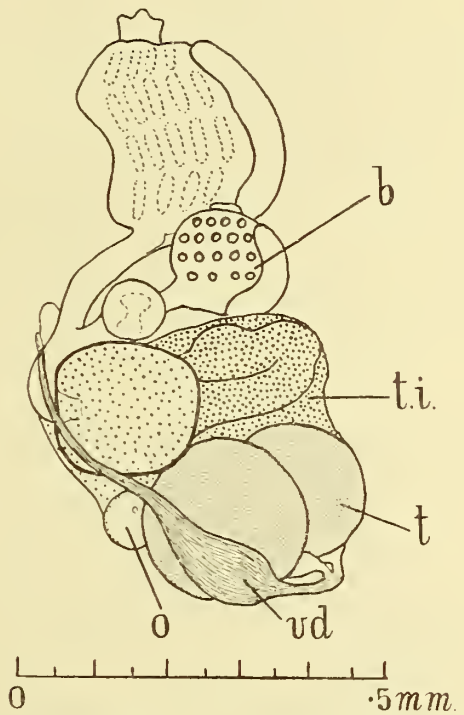
Occurrence.—Low Isles : G1, G3, F9, Reef Flat between F11 and IR1, IM1, Mangrove Park. Three Isles : Anchorage. Batt Reef : Patch No. 1.

After examination of the type material of *D. virens* (B.M. 07.8.30.42) some additions can be made to Herdman's description. There is a thin layer of test within the layer of bladder-cells and the centre of the colony is crossed by strands of test (" loose, lacunar test " of Herdman). The spherical green cells (Plate III, fig. A, *z*.) are only found in the spaces, not embedded in the test, and tend to be arranged in a single layer on the surface of the strands of test. It is, no doubt, the layer of these cells on the inner surface of the continuous layer of test that gives the optical effect of a dark green ring outside the zooids, which is mentioned by Herdman. The green cells are very numerous. The zooids, with a thin coating of test, are slung across the central cavity of the colony, only the branchial siphon being embedded in the main part of the test. The thorax in adult zooids is longer than in Herdman's figs. 39 and 40, which evidently represent young zooids. The stigmata, which are round in the buds, are fairly long in the adult. The constriction between thorax and abdomen is rather long. There is the usual bifid testis, with uncoiled vas deferens, which is dilated soon after leaving the testis.

Several congregations of small colonies from the Barrier Reef have been identified with Herdman's species. In life they were conspicuous for their green or blue colour.

Dr. C. M. Yonge has examined some of them, and finds that the spherical bodies are zooxanthellae. He thinks that the blue and green colours of the living colonies may be due to the combined effect of varying proportions of the yellow or brown colour of the zooxanthellae and a blue colour, presumably in the test. The green colour of these colonies would therefore not be of the same nature as that of the type-specimen, in which, according to Herdman, the algal cells were green. In the colonies from Ceylon with reddish-brown cells (*Diplosoma* sp. Herdman, 1906, p. 342) the general colour was reddish brown, not green. Dr. Yonge finds that the algal cells of the type are a different species from those in the Barrier Reef specimens.

Each colony has a single cloacal aperture. The specimens agree with *D. virens* in



Text-fig. 16.—*Diplosoma virens* (Hartmeyer). Zooid from Barrier Reef. (For explanation of lettering, see footnote, p. 73.)

forming small, loosely-attached colonies with the test drawn out into processes, in having numerous bladder-cells in the outer layer of the test, in having their central cavities more or less filled with algal cells, in the shape and distribution of the vascular processes, and in the form of the zooids (Text-fig. 16).

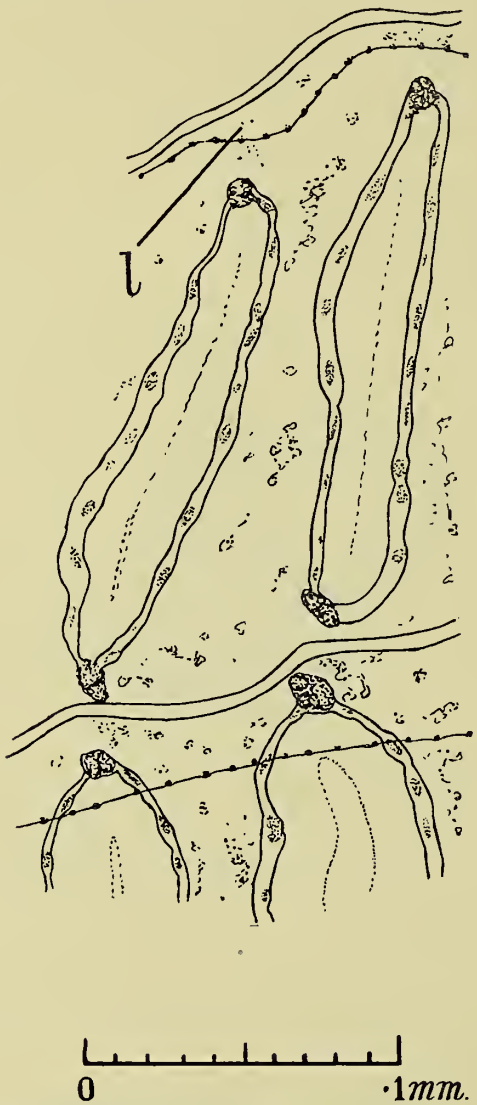
The chief difference is that in the Barrier Reef specimens strands of the test extending into the central cavity are not common, and are short and thick (Plate III, fig. B). There are differences in the main part of the test which may be due to less contraction in preservation, the bladder-cells being less closely packed and the inner layer being thicker and less dense. In the type this layer has a slightly striated appearance (*cf.* Plate III, figs. A and B).

Only three species of *Diplosoma* have been recorded from Australia, namely *D. rayneri* Macdonald (1859, p. 373), *Leptoclinum* (*Diplosoma*) *translucidum* Hartmeyer (1910, p. 1490) = *L. perspicuum* Sluiter (1909, p. 79), *D. spongiforme* var.? Michaelsen

(1930, p. 529). The two latter are clearly distinct from the present specimens, but *D. rayneri*, which was found at Port Jackson and has not been recorded since, agrees as far as its description goes. No mention is made, however, of any of the specific peculiarities of *D. virens*, some of which it is unlikely that Macdonald would have overlooked.

Diplosomoides ostrearium Michaelsen. (Text-fig. 17.)

Diplosomoides ostrearium Michaelsen, 1930, p. 526.



Text-fig. 17.—*Diplosomoides ostrearium* Michaelsen. Stigmata seen from the inner surface of the branchial sac. Cilia omitted, the position of their tips indicated by dotted line. *l.*, lamina on transverse bar.

Distribution.—Oyster Harbour, S.W. Australia.

Occurrence.—Mangrove Park, on *Cymodocea*.

Two small colonies, the largest 7 mm. × 4 mm., agree with Michaelsen's description. Like his specimens, they are growing on a linear leaf. They are described as purple when alive. The branchial sac is large and very delicate. The stigmata are large, and the

bars between them as wide as the stigmata. The epithelium on the stigmata consists of very flat cells with oval nuclei, and there are large, round cells in the angles (Text-fig. 17). A transparent membrane (*l*) projects inward from each transverse bar and has a row of nuclei in its edge. The thoracic tubercles are nearer to the endostyle than to the dorsal lamina. No reproductive organs were seen.

Michaelsen states that his species may be identical with one of the Malayan species of Gottschaldt or with *D. molle* Herdman (1886, p. 310). Examination of the type of *D. molle* (B.M. 87.2.4.446) shows that it is distinct. As in the specimens subsequently attributed to the species, there is a large, round cloacal opening at the summit of the more or less conical colony. The spicules are slightly more numerous in the surface layer than in *D. ostrearium*, and they are not found in the layer of test surrounding the zooids, except in the region of the thoracic tubercle. Their surface while in the tubercle is smoother than in those in the same position in *D. ostrearium*. These groups of spicules were not seen by Herdman (1891, p. 633). The tubercles themselves resemble those of *D. ostrearium* in form and position. The branchial sac is longer, being nearly twice as long as wide, and is not so delicate as that of the present specimens. The stigmata have the usual type of epithelium. The tentacles are thicker and less numerous. There is a pair of longitudinal muscles, mentioned by Herdman, on the dorsal edge of the thorax. They are continued into a retractor of unusual length, which, extending for a considerable distance beyond the abdomen, is conspicuous in the test. *D. ostrearium*, on the other hand, is without retractors.

Polyclinum macrophyllum subsp. *phortax* Michaelsen.

Polyclinum macrophyllum subsp. *phortax* Michaelsen, 1930, p. 546.

Distribution.—Shark's Bay, W. Australia.

Occurrence.—St. XXIII (1 colony).

This colony corresponds closely with Michaelsen's description. As in subsp. *typicum* the post-abdomen lies beside the abdomen, but, as pointed out by Michaelsen, this depends on the thickness of the colony. There is a wide cavity between the mantle and the branchial sac, traversed by conspicuous vessels which join the transverse vessels of the branchial sac. Zooids with a row of small, irregular stigmata were seen, and this row was not always the most posterior. The cloacal opening is bordered by finger-like processes occupied by parts of the tips of the atrial languets as figured by Michaelsen (1930, p. 54) in *P. constellatum*. There is a short atrial siphon.

THALIACEA AND APPENDICULARIA.

The details of the distribution of these groups of Tunicata will be found in Dr. Russell's report on the Plankton and, as the specimens call for no comment, it is sufficient to give a list of the species and a selection of references to the literature. *Megalocercus huxleyi* is only known from the Indo-Pacific region (Ihle, 1929). The other species are very widely distributed, being found, at least in the warmer waters, in the Atlantic, Pacific and Indian Oceans.

The absence of *Oikopleura cophocerca* is rather surprising. It was found, with the three species here recorded, on the S.W. coast of Australia (Lohmann, 1909, p. 144) and

in the Malayan region (Ihle, 1908, p. 118). A rather large proportion of the specimens of *Oikopleura* are unfit for certain identification, but there is no reason to suppose that there are among these any species not represented by those better preserved. Three individuals of *O. rufescens* had the more horizontal rectum described by Ihle (1908, p. 114).

Cyclosalpa pinnata (Forskål).

Salpa pinnata Forskål, 1775, p. 113.
Cyclosalpa pinnata Metcalf, 1918, p. 9, text-figs. 1–14, pls. i, ii (synonymy).

Salpa democratica Forskål.

Salpa democratica Forskål, 1775, p. 113.
Thalia democratica Sewell, 1926, p. 92, text-figs. 20–26 (synonymy).

Salpa zonaria (Pallas).

Holothurium zonarium Pallas, 1774, p. 27, pl. i, fig. 17 A, B, C.
Jasis zonaria Sewell, 1926, p. 88, text-figs. 18, 19 (synonymy).

Salpa cylindrica Cuvier.

Salpa cilindrica Cuvier, 1804, p. 381, pl. lxviii, figs. 8, 9.
Salpa cylindrica Sewell, 1926, p. 77, text-figs. 7–13 (synonymy).

Salpa confoederata Forskål.

Salpa confoederata Forskål, 1775, p. 115.
Pegea confoederata Sewell, 1926, p. 100, text-figs. 28–33. (synonymy.)

Salpa rostrata Traustedt.

Salpa rostrata Traustedt, 1893, p. 8, pl. i, figs. 1–4; Apstein, 1894, p. 16, pl. ii, figs. 9, 10, 17–22, text-fig. ix; Ihle, 1910, p. 27, pl. i, fig. 17.
Brooksia rostrata Metcalf, 1918, p. 50, text-figs. 22–24.

Doliolum denticulatum Q. & G.

Doliolum denticulatum Quoy & Gaimard, 1834, p. 599, pl. lxxxix, figs. 25–28; Neumann, 1906, p. 222, pl. xxiv, fig. 1 (development, pp. 100–206, figs.); Ihle, 1910, p. 15.

Doliolum tritonis Herdman.

Doliolum denticulatum Herdman, 1887, p. 101, pls. xviii–xx.
Doliolum tritonis Herdman, 1888, p. 47, pl. iii, fig. 3; Neumann, 1906, p. 220; Ihle, 1910, p. 14.

Asexual Doliolum.

Asexual specimens of *Doliolum* are not abundant in the collection, and the species of none of those found could be identified.

Fritillaria haplostoma Fol.

Fritillaria aplostoma Fol, 1872, p. 478, pl. vi, fig. 6.
Fritillaria haplostoma Lohmann 1896, p. 39, pl. v, figs. 1–3, 6 ; Ihle, 1908, p. 93 ; Essenberg, 1926, p. 442, text-figs. 52–56.

Oikopleura longicauda (Vogt).

Appendicularia longicauda Vogt, 1854, p. 74, pl. x, figs. 4–6.
Oikopleura longicauda Lohmann, 1896, p. 59, pls. ix, x, fig. 7 ; 1901, p. 19, text-fig. 23; Ihle, 1908, p. 111, pl. iii, figs. 40–43 ; Essenberg, 1926, p. 487, text-figs. 130–132.

Oikopleura fusiformis Fol.

Oikopleura fusiformis Fol, 1872, p. 473, pl. iii, figs. 5–8 ; Lohmann, 1896, p. 63, pl. xvi, fig. 3, pl. xvii, figs. 5, 7, 8 ; 1901, p. 20, text-fig. 24 ; Ihle, 1908, p. 113 ; Essenberg, 1926, p. 494, text-figs. 140–142.

Oikopleura rufescens Fol.

Oikopleura rufescens Fol, 1872, p. 471, pl. x, fig. 3 ; Lohmann, 1896, p. 74, pl. xvi, figs. 2, 4, pl. xvii, figs. 1–3, 6 ; Ihle, 1908, p. 114, pl. iv, figs. 69–73 ; Essenberg, 1926, p. 491, text-figs. 136–139.

Stegosoma magnum (Langerhans).

Oikopleura magna Langerhans, 1880, p. 145, pl. vi, fig. 73.
Stegosoma magnum Lohmann, 1896, p. 79, pl. xviii ; Ihle, 1908, p. 115 ; Essenberg, 1926, p. 505, text-figs. 154–158.

Megalocercus huxleyi (Ritter & Byxbee).

Oikopleura huxleyi Ritter & Byxbee, 1905, p. 206, pl. ii, figs. 9–11.
Megalocercus huxleyi Ihle, 1908, p. 98, pl. i, fig. 1–8, pl. ii, figs. 9–13, 16–22, pl. iii, figs. 31, 32, 37–39, text-figs. 9, 10 ; Lohmann, 1914, p. 353, text-figs. 1, 2*a*, 3*a* and *c*, 4*a*, 5, 6*a*.

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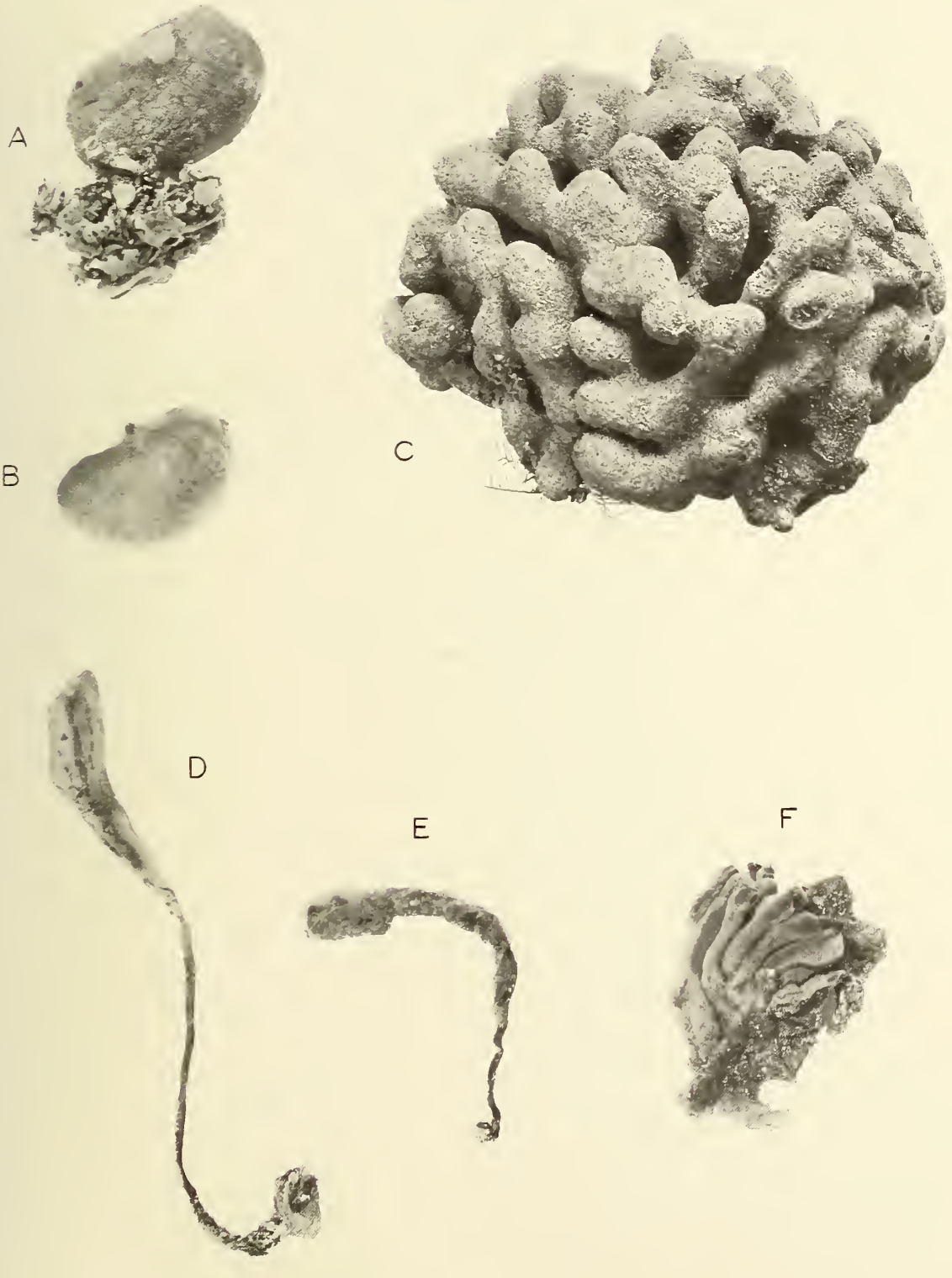
DESCRIPTION OF PLATE I.

A and B, *Polycarpa ovata* Pizon. Natural size. B, After removal of test.

C, *Eudistoma ovatum* (Herdman) from Cape Boileau, N.W. Australia. × ½.

D and E, *Podoclavella meridionalis* Herdman. Natural size. D, From the Barrier Reef. E, From Cape Boileau.

F, *Podoclavella molluccensis* Sluiter from Cape Boileau. Natural size.



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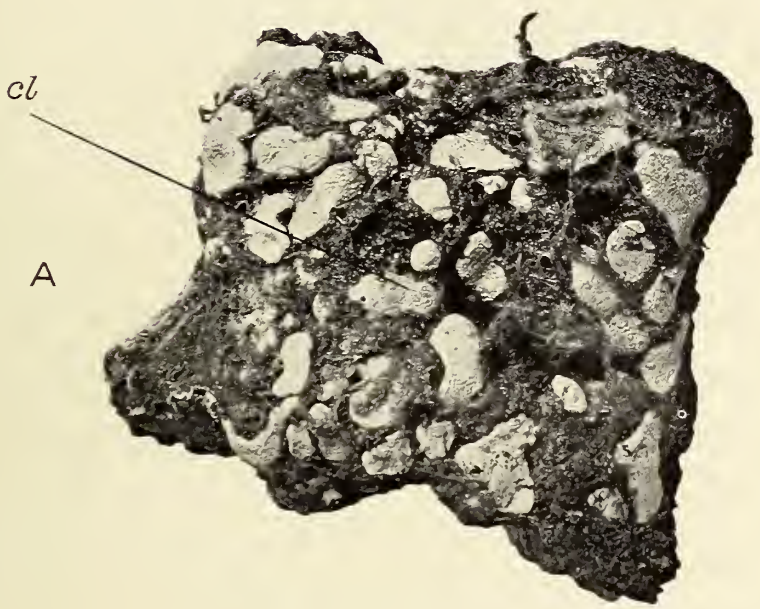
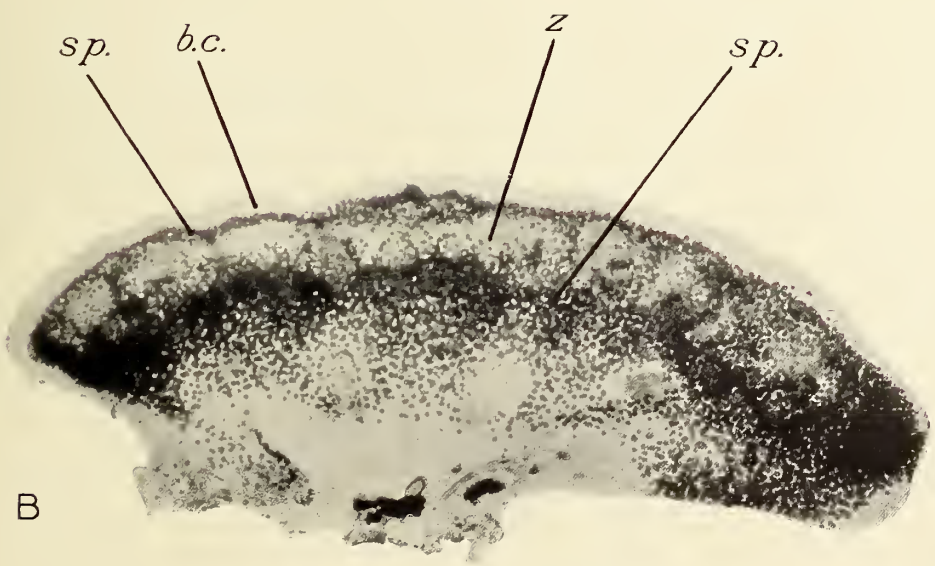
DESCRIPTION OF PLATE II.

A, *Didemnum candidum* Sav., pink form, from Thalamita Flat, Low Isles. Natural size. Several cloacal apertures are visible.

B, *Tridemnum cyclops* Michaelsen. × 24. Vertical section. *b.c.* Bladder-cell layer. *cl.a.* Cloacal aperture. *z.* algal cells. *sp.* Spicules.

Brit. Mus. (*Nat. Hist.*). REPORTS, VOL. IV, NO. 3. PLATE II.





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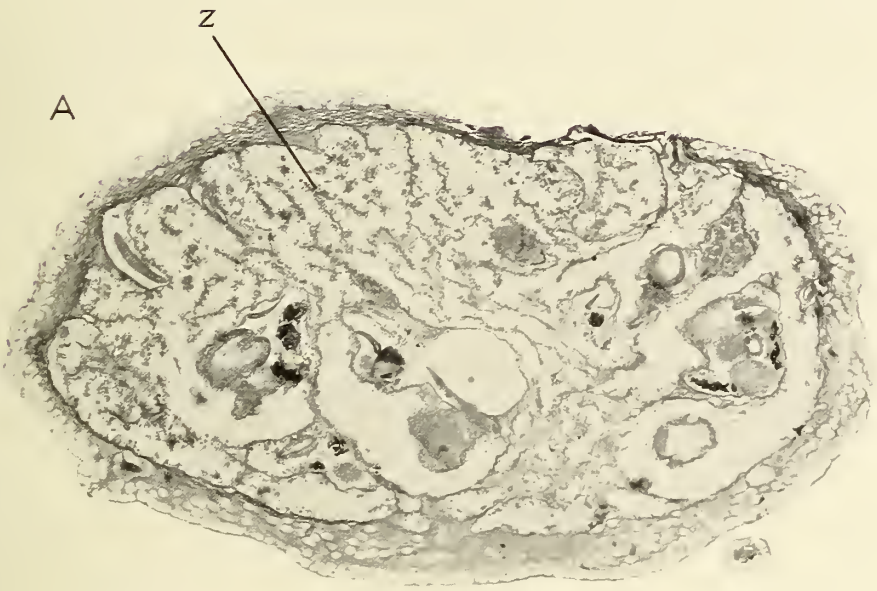
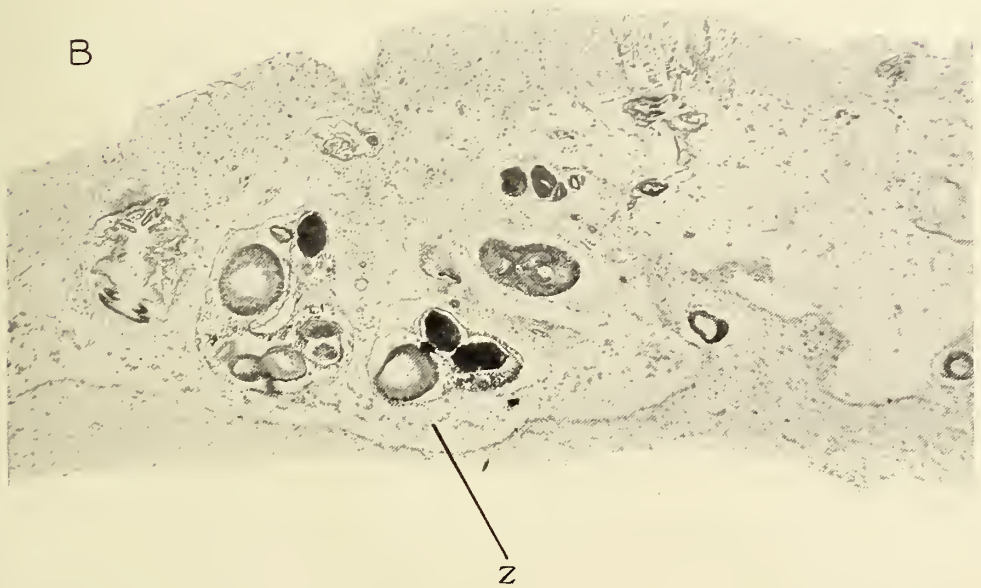
DESCRIPTION OF PLATE III.

A and B, Sections of *Diplosoma virens* (Hartmeyer). × 56. A, Type-specimen from Ceylon. B, Colony from Mangrove Park, Low Isles. *z*. Algal cells.





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